2018

2018 Annual Environmental and Reclamation Report

Mount Polley Mining Corporation

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2018 Annual Environmental and Reclamation Report for the Mount Polley Mine

Submitted to:

BC Ministry of Energy, Mines, and Petroleum Development
(Mines Act **Permit M-200)**

And

BC Ministry of Environment and Climate Change Strategy
(Environmental Management Act **Permit 11678)**

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EXECUTIVE SUMMARY

In 2018, Mount Polley Mining Corporation mined 3,316,818 tonnes of ore and 4,482,324 t of waste rock from the Cariboo Pit. Approximately 5% of the waste mined was potentially acid generating and was transported to the Temporary Potentially Acid Generating Stockpile. Approximately 6,166,566 t of tailings were deposited into the Tailings Storage Facility. In 2018, MPMC milled 6,195,760 tonnes of ore and produced 14,973,630 pounds of copper, 37,120 pounds of gold, and 33,458 pounds of silver. Next year's production is projected to end with the mill shut-down as part of a Care and Maintenance program that will go into effect May 31, 2019. Low copper prices are cited as the reason for this action. Between January and May 2019, mill feed will be provided by stockpiled ore. Mining will resume once economic conditions improve. The environmental monitoring and remediation work programs will continue in 2019. The current permitted projected date of mine closure is 2022.

As permitted by the *Environmental Management Act* Permit 11678, the Water Treatment Plant operated intermittently in 2018 and discharged a total of 5,174,175 m^3 of water. The annual average discharge rate was 16,789 m^3/day and daily maximum discharge rates ranged from 0 m^3/day to 21,884 m^3/day. Reporting to Environment and Climate Change Canada under the Federal *Metal and Diamond Mining Effluent Regulations* continued accordingly.

Environmental management and monitoring in 2018 followed guidelines and procedures contained in the *Comprehensive Environmental Monitoring Plan* and was in accordance with regulations contained in *Environmental Management Act* Permit 11678 and *Mines Act* Permit M-200. Monitoring followed the outline of the 2016 *Comprehensive Environmental Monitoring Plan* from January 1 to Nov 8, 2018 until the updated 2018 *Comprehensive Environmental Monitoring Plan* was approved on November 9, 2018 and immediately came into effect. Mining activities including production summaries and reclamation follow requirements contained in *Mines Act* Permit M- 200. Water chemistry results from monitoring sites were compared with appropriate permitted limits and British Columbia Water Quality Guidelines for aquatic life.

There were six (6) instances of results triggering the *Environmental Management Act* Permit 11678 limit exceedance. However, following investigations, only the total copper and dissolved cadmium exceedances at the discharge in May were deemed non-compliant. Proper notification was sent to the Director and other required parties, the Water Treatment Plant was promptly shut down, an investigation was undertaken, and mitigation works completed.

In 2018, there were two unauthorized releases of mine-affected water. Notifications and follow-up reports were submitted to Ministry of Environment and Climate Change. There was one (1) spill reported to Emergency Management BC.

Two events in 2018 contributed to loss of data and delays in remediation projects are described below:

1) The Mount Polley Mine site experienced a cyberattack on June 11, which encrypted or deleted many computer data files and all the MPMC network files from 2018. Most data files created by MPMC between December 31 2017 and June 11, 2018 cannot be included in this report.

2) Unionized employees were on strike from May 23 to August 2, 2018. The strike delayed scheduled projects

such as the remediation of Reach 3 in Hazeltine Creek and construction of the wetlands.

MPMC is currently under a *Pollution Abatement Order* 107461. On January 31, 2018, MPMC submitted a *Conceptual Remediation Plan* to Ministry of Environment and Climate Change as the last deliverable of the *Pollution Abatement Order*. ENV provided review comments on the *Conceptual Remediation Plan* on December 11, 2018 and MPMC will address the comments and move towards finalizing the document. All requirements of this *Pollution Abatement Order* have been met.

Progressive reclamation within the mine site included applying soil over 2.89 ha and planting trees over a 22 ha area. Significant revegetation work was carried out as part of the remediation of Hazeltine Creek and the floodplain areas including ripping, mounding and planting of the adjacent terrestrial areas, and channel reconstruction for fish habitat in Reach 3 (below the Gavin Lake road bridge). Construction of the fish habitat commenced in early August and 1 kilometer of remediation work was completed in early October.

Certain studies were initiated in 2018 focusing on mine closure related reclamation practices:

1) Geomorphic Slope Guidance document will provide guidelines for site slope recontouring and stream rehabilitation at and around the Mount Polley Mine and will also provide guidance for engineering works that would result in a natural looking slope upon closure.

2) Soil Cover Test Plot Design which when completed may provide guidance to determine a reclamation cover soil design that reduces infiltration of water into and mass loading of constituents from waste rock disposal sites.

3) As an integral component of long term site water management, passive water treatment studies were initiated in 2018 that included in situ pit lake treatment studies. The focus of these studies is to reduce constituents of concern in mine influenced water. Bench scale testing was initiated in 2018. Additional studies involve the evaluation and feasibility of other semi-passive and passive systems including sand filtration, biochemical reactors, packed bed reactors, and sulphide polishing cells. Constructed wetlands were also built in 2018 that will test whether mine water can be effectively treated through wetlands technology. For all these potential water treatment options, additional work will be carried out in 2019.

   As a more active treatment option, design work and bench scale testing was conducted on water that is treated by the Water Treatment Plant as part of the Copper Optimization Study. This study focuses on the use of reducing effluent copper levels by testing different flocculants to settle suspended solids more effectively which will reduce metal concentrations including copper. A pilot scale test will be conducted in 2019.

Stakeholder engagement in 2018 included two (2) Implementation Committee meetings, five (5) Public Liaison Committee meetings, four (4) community meetings, a Mining Association of Canada meeting that included a site tour and a round table discussion, and a site tour and presentations by the Technical and Research Committee on Reclamation. Additionally, there was a site tour with Elders from the Williams Lake Indian Band.

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APPENDICES

ACRONYMS AND ABBREVIATIONS

ABA	Acid-Base Accounting
ABR	Anaerobic Biological Reactor
ADSI	Annual Dam Safety Inspection
AERR(s)	*Annual Environmental and Reclamation Report*
ADP	*Annual Discharge Plan*
ARD	Acid Rock Drainage
ARD/ML	Acid Rock Drainage/Metal Leaching
BC	British Columbia
BCR	Biochemical Reactors
BC WQG	British Columbia ENV Water Quality Guideline
BC WWQG	British Columbia ENV Working Water Quality Guideline
CCS	Central Collection Sump
CEMP	*Comprehensive Environmental Monitoring Plan*
CFIA	Canadian Food Inspection Agency
CMDRC	Cariboo Mine Development Review Committee
COC	Chain of Custody
COPC	Contaminant(s) of Potential Concern
CRP	*Conceptual Remediation Plan*
CWTS(s)	Constructed Wetland Treatment System
DFO	Department of Fisheries and Oceans
DGR	Dangerous Good Regulations
DGT	Diffusive Gradient in Thin Films Device
DI	Deionized water
DQO	Data Quality Objectives
DSR	Dam Safety Review
EDC	Edney Creek
EEM	*Environmental Effects Monitoring*
ELS	Early Life Stage
EMA	*Environmental Management Act*
EMP	Environmental Management Plans
EMPR	Ministry of Energy, Mines and Petroleum Development
ENV	Ministry of Environment and Climate Change Strategy
EoR	Engineer of Record
ERA	*Ecological Risk Assessment*
GW	Groundwater
HAC	Hazeltine Creek
HHRA	*Human Health Risk Assessment*
HSRC	*Health, Safety and Reclamation Code for Mines in British Columbia*
IC	Implementation Committee
IDZ	Initial Dilution Zone
IM	Imperial Metals
KEM1/KEM2	Kemmerer water sampler
LCRS	Leachate Collection Recycle System
LD	Long Ditch
LTWMP	*Long-Term Water Management Plan*

MAC	Mining Association of Canada
MDL	Method Detection Limit
MESCP	Main Embankment Seepage Collection Pond
MDMER	*Metal and Diamond Mine Effluent Regulations*
MPMC	Mount Polley Mining Corporation
MTD	Main Toe Drain
NAG	Non-Acid Generating
NBD	North Bell Dump
NEZ	Northeast Zone
NPR	Neutralizing Potential Ratio
NW	Temporary Northwest
OMS	Operation, Maintenance and Surveillance [Manual]
PAG	Potentially Acid Generating
PAO	*Pollution Abatement Order*
PEEIAR	*Post-Event Environmental Impact Assessment Report*
PETBP	Perimeter Embankment Till Borrow Pit
PESCP	Perimeter Embankment Seepage Collection Pond
PLC	Public Liaison Committee
POI(s)	Parameter(s) Of Interest
PTD	Perimeter Toe Drain
PVR	Post Verification Review
QA/QC	Quality Assurance/Quality Control
QP	Qualified Professional
QPO	Quantitative Performance Objectives
QUL	Quesnel Lake
QUR	Quesnel River
RCP	*Reclamation and Closure Plan*
RDS	Rock Disposal Site
RPD	Relative Percent Difference
SCIB	Soda Creek Indian Band
SERDS	Southeast Rock Disposal Site
SEZ	Southeast Zone
STD	South Toe Drain
SWE	Snow Water Equivalent
TAR	*Technical Assessment Report*
TDAR	Tailings Dam Access Road
ToR	Terms Of Reference
TRCR	Technical Research Committee on Reclamation
TRP	*Trigger Response Plan*
TSF	Tailings Storage Facility
TSM	Towards Sustainable Mining
TSS	Total Suspended Solids
WHR	Waste Haul Road
WLIB	Williams Lake Indian Band
WTP	Water Treatment Plant

Units

°C	degrees Celsius
dt	dry tonnes
ft	feet
g/t	grams per tonne
ha	hectare(s)
kg	kilogram(s)
km	kilometer(s)
L	liter(s)
lbs	pounds
m	metre(s)
masl	metres above sea level
m^3	cubic metre(s)
m^3/s	cubic metre(s) per second
mm	millimeter(s)
mg/L	milligrams per litre
oz	ounce(s)
µS/cm	micro Siemens per centimeter
%	percent
ppm	parts per million
t	tonne(s)
tpd	tonne(s) per day

Consultants and Laboratories

ALS	ALS Environmental Inc.
Contango	Contango Strategies Ltd.
Golder	Golder Associates Ltd.
Maxxam	Maxxam Analytics Inc.
Minnow	Minnow Environmental Inc.
Nautilus	Nautilus Environmental Inc.
Spectrum	Spectrum Resources Group Inc.
SRK	SRK Consulting Inc.
Tetra Tech	Tetra Tech Inc.
WaterSmith	WaterSmith Research Inc.

1 Introduction

Mount Polley Mining Corporation (MPMC) is required to submit two (2) annual reports; one (1) to the British Columbia (BC) Ministry of Environment and Climate Change Strategy (ENV), and a second to the BC Ministry of Energy, Mines & Petroleum Resources (EMPR) as per the by *Environmental Management Act (EMA)* Permit 11678 and *Mines Act* Permit M-200, respectively. Beginning with the reporting year of 2000 and continuing through 2018, these two reports have been combined into one (1) comprehensive report for submission to both ministries under the title of the *Annual Environmental and Reclamation Report* (*AERR*). In addition to presenting data and review from 2018, the *EMA* Permit 11678 requires a three (3) year detailed monitoring program interpretive report. This *AERR* fulfills this requirement.

In 1995 and 1996, an environmental monitoring program, which expanded on previous studies from 1989 and 1990, was designed and implemented to support mine planning, operations, and reclamation activities at the Mount Polley Mine. The program included baseline studies documenting the pre-development land uses and the conditions of the aquatic and terrestrial ecosystems. This information provides the foundation upon which operational environmental monitoring programs were, and continue to be, based. The November 29, 2015 *EMA* Permit 11678 amendment included a revised condition, to develop a *Comprehensive Environmental Monitoring Plan* (*CEMP*) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek (HAC), Edney Creek (EDC), Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake (QUL), Quesnel River (QUR), and associated riparian and upland areas. The *CEMP* was submitted to the ENV on June 23, 2016 and an updated *CEMP* was submitted to the ENV August 5, 2018, and was approved on November 9, 2018. Both *CEMP*s are provided in Appendix A along with the amended *EMA Permit 11678* from April 7, 2017 and from October 2, 2018.

In 2018, MPMC encountered some challenges that contributed to the loss of data and delays in remediation and construction projects. The Mount Polley Mine site experienced a cyberattack on June 11, which encrypted or deleted many computer data files and all the MPMC network files from 2018. Most data files created by MPMC between December 31, 2017 and June 11, 2018 cannot be included in this report. Data from outside sources was resaved and are included. Unionized employees were on strike from May 23 to August 2, 2018. The strike delayed scheduled projects such as the remediation of Reach 3 in Hazeltine Creek and construction of the wetlands.

1.1 Monitoring Objectives

Environmental monitoring according to the 2016 *CEMP* (Appendix A) was undertaken until November 9, 2018 when the 2018 *CEMP* was approved by ENV. The *CEMP* fulfills both the requirements of the *Mines Act* Permit M–200 and *EMA* Permit 11678 (Appendix A) .The objective of this monitoring is to assess the environmental effects of mining activities at Mount Polley Mine on the receiving environment.

Monitoring results for 2018 are reported in subsequent sections of this report as follows:

- Chemistry and quantity of surface, seepage, and groundwater (GW);
- Aquatic biology;
- Water levels in groundwater wells;
- Stream flows and water levels;
- Meteorology (temperature, precipitation, snowpack, evaporation rates); and
- Wildlife observations.

1.1.1 Reclamation Objectives

In accordance with the *BC Mines Act* and the *Health, Safety and Reclamation Code for Mines in British Columbia*, the primary objective of the *Reclamation and Closure Plan* (*RCP*) (MPMC, 2017a) is to:

> *"return all mine-disturbed areas to an equivalent level of capability to that which existed prior to mining on an average property basis, unless the owner, agent or manager can provide evidence which demonstrates to the satisfaction of the chief inspector the impracticality of doing so".*

To achieve these objectives, reclamation and closure prescriptions are continually being refined based on the results from the ongoing reclamation research program (Section 10). An updated *RCP* was submitted to the EMPR on January 15, 2017 (MPMC, 2017a).

The main objective of the reclamation program is to return all areas that have been disturbed by mining operations (except pit walls) to equivalent or greater land capability than existed prior to mining, on an average property basis. To achieve this objective, MPMC has proposed end land use objectives that are based on an ecosystem approach. The ecosystem approach considers diverse ecosystem components and the resulting ecosystem services in reclamation planning. These ecosystems can be mapped on appropriate areas of the landscape, but rather than limiting each area to one (1) designated end land use (e.g., wildlife habitat), this approach will allow for multiple, compatible end land use objectives to be targeted. End land uses that are encompassed in the target ecosystems over time include forest cover, wildlife habitat, hunting, trapping, guide outfitting, traditional use, livestock grazing, and recreation.

An *End Land Use Plan*, included in the *RCP*, (MPMC, 2017a) has been developed that focusses on ecosystem rehabilitation as the main goal with a target towards ecosystems that existed prior to the development of the mine (Section 10). The *End Land Use Plan* also estimates shifts in the end land use objectives over time as the ecological trajectories of the ecosystem mature. This ensures that end land use planning is considered over the long-term and that a variety of end land uses can occur on the landscape over different temporal scales.

The following goals are implicit in achieving these end land use objectives:

- Long-term preservation of water quality within and downstream of decommissioned operations;
- Long-term stability of engineered structures, including the waste rock dumps, Tailings Storage Facility (TSF), and open pits, as well as all exposed erodible materials;
- Removal and proper disposal of all access roads, structures, and equipment not required after the Mine closes;
- Natural integration of disturbed lands with the surrounding landscape and restoration of the natural appearance of the area after mining ceases; and
- Establishment of self-sustaining vegetation covers consistent with the end land uses.

Once these aspects are in place, flexibility exists to modify ecosystem composition, patch size, and vegetation mosaic and to provide additional structural components, as required. By reclaiming disturbed land to stable, functioning, locally appropriate ecosystems that can reasonably be expected to thrive on a specific landform or location, a variety of end land use objectives can also be met.

End land use objectives envelop a multitude of values that may exist beyond ecological conditions and are driven by what regulators, MPMC, First Nations, and local communities prefer for the landscape once the Mine is closed. End land use decisions are influenced by several factors, including:

- Permit obligations;
- Regulatory requirements;
- Landform design;
- Surface and subsurface materials at closure;
- Surface water hydrology;
- Slope;
- Aspect,
- Elevation;
- Input from First Nations, local communities and stakeholders; and
- Traditional and cultural land use.

End land use objectives may be adapted over time as interests evolve; however, once a landform is constructed, the end land uses are limited to the conditions and ecological trajectories associated with the particular ecosystem that has been rehabilitated.

Site research that was initiated at the Mine in 1998 indicates that conifer growth on reclaimed waste rock dumps is an attainable goal for parts of the Mine site. However, to create appropriate microsites for conifers that grow in later successional stages, it is often necessary to promote early successional stage vegetation growth, allowing the process of natural succession to establish suitable vegetation cover and moisture conditions. Establishment of early successional stage communities can effectively support functioning ecosystems. Over time, as succession and native species ingress occur at reclamation sites, climax forest communities will be established.

Rehabilitation of the Mount Polley Mine site's wildlife capability will require development of self-sustaining vegetation that imitates pre-development cover. Recreation of the natural appearance and creation of suitable habitats will allow for natural integration of disturbed lands into the surrounding landscape and improve wildlife use and access over time once the Mine has reached full closure. Post-closure, as wildlife usage increases and public access to parts of the site is re-established, the government will have the opportunity to sanction the end land uses of hunting, guide outfitting, and trapping.

Similarly, livestock grazing is a compatible end land use as there is overlap in wildlife and livestock forage species and vegetative cover preferences. Other forms of outdoor recreation, including sport fishing, will be supported by maintaining appropriate water quality and aquatic habitats in receiving environment water bodies.

1.1.2 Ministry of Energy, Mines and Petroleum Resources

The Annual Reclamation Report for the EMPR, as required by *Mines Act* Permit M–200, requires a summary and description of the past year's mining and reclamation program including:

- A summary of disturbed areas and surface development.
- Updated disposal or storage locations for tailings, waste rock, ore, overburden or other materials, and associated volumes.
- A description of the environmental protection program over the reporting year and projected changes to the program, including surface water and groundwater quality, water management, Acid Rock Drainage/Metal Leaching (ARD/ML) characterization and management, wildlife protection, and sediment and erosion control.
- Drainage monitoring programs, including flows and water quality.
- Geological characterization and material characterization test work.
- An update on completed site reclamation, reclamation research, and reclamation plans for the next 5 years.
- Reclamation liability cost estimates.

1.1.3 Ministry of Environment and Climate Change Strategy

As per the most recent amendments of *EMA* Permit 11678 (April 7, 2017 and October 2, 2018; Appendix A) the Annual Report must include:

a) All monitoring sample quality results required under the permit.
b) An evaluation of quality assurance, including collection, sampling, and data handling protocols.
c) An evaluation of the treatment plant operation and control.
d) An evaluation of the impacts of the mining operation on the receiving environment from the previous year.

e) A summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment.
f) An update to the water balance, and a calibration assessment of the water balance and water quality models
g) An assessment of the outfall dispersion and dispersion modelling for the Quesnel Lake discharge
h) An update to any modeling related to the Springer Pit groundwater seepage and its impacts on Bootjack Lake.
i) A progress update with respect to the final water management plan.
j) A review and update of the assessment of ARD potential and water quality impacts from mine waste management.
k) A comparison of monitoring data with British Columbia water quality guidelines (BC WQG), (ENV, 2017; ENV, 2018) predictions and targets.
l) An update on the progress of reclamation and any updates to the reclamation plan.
m) An evaluation of the effectiveness of the Surface Runoff and Mine Drainage Control programs.
n) A summary of the Public Liaison Committee meetings, and issues and concerns presented.
o) An evaluation of the Outfall and Pipeline Inspection programs.
p) Trend analysis (graphs) of water monitoring data at each site for the past five years.

The purpose of this document is to allow the ENV to: identify whether spills or incidents have been reported and addressed; evaluate permit compliance; identify environmental effects; verify predictions of effects; and identify whether the permit adequately protects the environment or if changes are required.

1.2 First Nations and Stakeholders

1.2.1 First Nations Engagement

First Nations with recognized claimed traditional territory for the Mount Polley Mine are the T'exelc (Williams Lake Indian Band; WLIB) and the Xatśūll First Nation (Soda Creek Indian Band; SCIB). In 2011 and 2012, MPMC executed Participation Agreements with the WLIB and the SCIB, respectively. In August 2016 and April 2017, MPMC renewed the agreements with WLIB and SCIB (respectively). Through these respective Participation Agreements, Implementation Committees (IC) were formed to facilitate open dialogue between each of the First Nations and MPMC, providing a formalized, regular venue to discuss environmental, social and economic matters related to mine development, operation, reclamation, and closure (e.g., mine updates, permitting, environmental protection, reclamation, employment opportunities, and potential joint ventures). Meetings have taken place since March 16, 2012 with the WLIB and since July 19, 2012 with the SCIB. Effective October 18, 2012, Joint IC meetings have been held with representatives from MPMC, the WLIB, and the SCIB, replacing the previous MPMC/SCIB and MPMC/WLIB Implementation Committee meetings. Joint IC meetings are held at a minimum on a quarterly basis, but typically more frequently. These meetings and associated documentation ((Terms of Reference (ToR), minutes, and action items) provide a well-defined constructive forum in which issues, reviews, and comments relating to the current and anticipated future operations of the Mount Polley Mine may be discussed. The 2018 *AERR* will be provided to the SCIB and the WLIB. Any comments or concerns will be facilitated through the Joint IC.

Two (2) Joint IC meetings were held in 2018. The reason for only two (2) meetings stems from the aftermath of the 2017 wildfires. Both the WLIB and SCIB were involved in multiple projects related to the impacts on the First Nation communities as a result of the fires.

IC meetings were held on October 16, 2018 and December 11, 2018. MPMC provided a presentation to the WLIB Chief and Council on May 7, 2018. The presentation included updates on employment and the mine plan for 2018, an update on remediation in the creek, an overview of the findings of the risk assessment reports (Section 2.1.1.1), and an introduction to the *Conceptual Remediation Plan (CRP).*

A site tour occurred on October 12, 2018 that included Elders from the WLIB.

On December 11, 2018, information focusing on the *CRP* was presented to the community of Sugar Cane (WLIB) as part of regional community engagement. Presentations were also given in Quesnel, Williams Lake and Likely.

1.2.2 Regional Mine Development Review Committee

In 2014, the Regional (Cariboo) Mine Development Review Committee (CMDRC) was revived by the EMPR. The CMDRC is a regionally-based multi-agency review committee chaired by the EMPR. Participants include representatives from MPMC, local, provincial, and federal government agencies and First Nations. Members of the public are also invited to participate on a topic-specific basis. There were no CMDRC meetings held in 2018.

The CMDRC also acts as a venue for communication related to permit amendment applications under the *EMA* permits, or other regulations administered by the ENV and the BC Ministry of Forests, Lands and Natural Resource Operations & Rural Development. While communication related to *EMA* Permit 11678 amendments will be conducted as per the *EMA* Public Notification Regulation, information is presented through the CMDRC where possible to coordinate review and consultation with parallel *Mines Act* permit amendments and other updates on the Mount Polley Mine site. The goal being to make efficient use of CMDRC member's (government, First Nations, and community representatives) time.

1.2.3 Public Liaison Committee

The intention of the Public Liaison Committee (PLC) is to provide an opportunity for MPMC to share information about mine activities and monitoring results with its members. These members are comprised of public stakeholders, First Nations and government. The members are then responsible for relaying information between MPMC and the group or individuals for which they are the Designated Representative.

MPMC held five (5) PLC meetings in 2018: February 15, 2018; June 26, 2018; August 16, 2018, October 2, 2018 and November 19, 2019 (as an extraordinary meeting). A site tour was completed during October 2 meetings along with members of the Mining Association of Canada and their Community of Interest Panel. All minutes for the 2018 PLC meetings are included in Appendix C.

The *EMA* Permit 11678 amendment issued April 7, 2017, required MPMC to develop updated ToR for the PLC in consultation with the committee members. The ToR was revised in 2018 in an effort to improve collaboration and communication. A final draft was circulated at the end of November 2018 and will be put forth for approval by the PLC during the first meeting of 2019.

The *EMA* Permit 11678 *(*Appendix A) requires that a summary of the PLC meetings and issues and concerns be presented in this annual report. MPMC has chosen not to provide this as a summary but instead has provided the meeting minutes in full in Appendix C.

In 2018, most of the PLC meetings were well attended with between 15 and 20 attendees at each meeting. Lists of the attendees are included in the meeting minutes in Appendix C. At each of the regular PLC meetings, MPMC provided an update regarding the mine site, the water management planning including an overview of the water discharge system and the current water balance, and all environmental monitoring. As outlined in the ToR, the PLC is intended to provide opportunity for MPMC to share information about the mine's activities and the results of monitoring programs with PLC members, and for members to share such information with their respective community.

1.2.4 Communication Plan

The April 7, 2017 amended *EMA* Permit 11678 required MPMC to develop and submit an update to the *Communication Plan*, in consultation with stakeholders, by June 30, 2017. This plan addresses the sharing of environmental data with WLIB, SCIB, Cariboo Regional District and the community of Likely. This deadline was extended to October 20, 2017 to allow for more consultation, and then to compensate for the interruption caused by forest fires. Ultimately, the consensus was that the plan was complete as it was originally written in 2016 and did not require updating. The *Communication Plan* was formally approved by ENV on January 19, 2018.

1.2.5 Mining Association of Canada

Mount Polley, as a member of the Mining Association of Canada (MAC), subscribes to the Towards Sustainable Mining (TSM) criteria developed by MAC. TSM requires that members adhere to a set of guiding principles that are supported by specific performance indicators against which member companies must report their results. All MAC members must report against indicators in the following performance measurement protocols:

- Aboriginal and Community Outreach
- Energy and Greenhouse Gas Emissions Management
- Tailings Management
- Biodiversity Conservation Management
- Safety and Health
- Crisis Management and Communications Planning

- Preventing Child and Forced Labour

On October 2, 2018, the Communities of Interest Panel from the MAC joined the MPMC PLC meeting and tour of the remediation on going in Hazeltine Creek. The notes from that meeting are included in Appendix C. In addition to the PLC meeting, the MAC panel also met with MPMC to complete a post verification review (PVR). The purpose of the PVR is to try and build a meaningful dialogue with the companies selected to undergo the PVR process to gain a better understanding of the successes and challenges regarding the key environmental and social issues in mining; to challenge the companies on their performance; and determine whether verification is working as the Panel expected. The PVR is essentially an "After-Action Report" reporting on the results of a member company's response to the Towards Sustainable Mining (TSM) performance criteria.

1.2.6 Technical and Research Committee on Reclamation – 2018 Symposium

The Technical Research Committee on Reclamation (TRCR) meets annually in BC to provide researchers and practitioners an opportunity to present papers, and for the attendees to tour different reclamation projects throughout BC. In September 2018, the TRCR Symposium was held in Williams Lake. The agenda included a full day Mount Polley workshop and a full day guided tour of the remediation work on-going on the Mine site and the in Hazeltine Creek corridor. MPMC was honoured to present the guided tour made up of a total of 144 mining and reclamation professionals from around the province. The day was concluded by an impressive dinner hosted by the Likely Lodge.

1.3 Qualified Professionals

Section 2.15 of the *EMA* Permit 11678 requires, "[a]ll documents submitted to the Director must be signed by the author and where specifically required by this permit, authored and signed by a Qualified Professional [QP]". Further to that, Section 3.9 requires, "[m]onitoring data and the analysis of that data, as it will be presented in the annual report, must be reviewed by a third party QP". The sections of this annual report that fall under these requirements are provided in Table 1.2 along with the QP that has reviewed or authored that section. Seals, where appropriate, have been provided in the applicable appendix, which are also summarized in Table 1.1.

Table 1.1 Annual report sections reviewed by a Qualified Professional

Section	Area	Qualified Professional	Appendix
7.9; 8.3	Hydrology	Russell Smith, RPF: WaterSmith Research Inc (WaterSmith)	K
6; 7.1; 8.1-8.2	Surface Water (including Hazeltine Creek), Lake Water Quality, Discharge Water Quality	Barbara Wernick, R.P. Bio.: Golder Associates Ltd. (Golder)	E
5.2; 7.2	Groundwater (All)	Jacqueline Foley, Geo.L; Gizachew Demissie, E.I.T.: Golder	F
7.3-7.6; 8.4-8.6	Sediment, Benthic, Fish, Periphyton, Plankton	Pierre Stecko, R.P. Bio; Katharina Batchelor, R.P. Bio: Minnow Environmental Inc. (Minnow)	J
7.8-7.9	Terrestrial Monitoring	Blair McDonald, R.P Bio; Barbara Wernick, R.P. Bio: Golder	M

2 Mount Polley Mine Project Overview

2.1 Project History

Mount Polley Mine, operated by MPMC (a wholly owned subsidiary of Imperial Metals (IM) Corporation), is an open pit copper/gold mine with an underground component, and has the capacity to process 20,000 to 22,000 tonnes per day (tpd) of ore. The Mine is located eight (8) kilometres (km) southwest of Likely and fifty-six (56) km (100 km by road) northeast of Williams Lake, BC (Figure 2.1). The Mount Polley Mine property covers 18,892 hectares (ha), which consist of seven (7) mining leases totaling 2,007 ha, and forty-five (45) mineral claims encompassing 17,594 ha. Mount Polley Mine concentrates are trucked to facilities at the Port of Vancouver, then shipped to overseas smelters or transported by rail to smelters in North America.

Clearing of the site and construction of the entire facility began in 1995, with the mill commissioned in June 1997. In May 1997, the Mine received an ENV (previously the Ministry of Water, Land and Air Protection) Effluent Permit, *EMA* Permit 11678, issued under the provisions of the provincial *EMA*. This permit authorized the discharge of concentrator tailings, mill site runoff, mine rock runoff, open pit water, and septic tank effluent to a tailings impoundment. Approval of the original Mount Polley Mine Reclamation and Closure Plan by the EMPR resulted in the issuance of *Mines Act* Permit M–200 in July 1997. The first full year of mining and milling at Mount Polley Mine took place in 1998. The Mine suspended operations in October 2001 due to low metal prices, then reopened in December 2004, with mill production commencing in March 2005.

A summary of *EMA* Permit 11678 amendments is provided in Table 2.1.

Table 2.1 Summary of *EMA* Permit 11678 amendments

Date	Scope of Amendment
30-May-1997	Original permit
20-Oct-1997	Amended authorized tailings discharge rate (10,000 tpd increase)
12-Jun-1998	Amended reporting requirements
8-Sep-1999	Amended monitoring requirements
1-Feb-2000	Amended authorized tailings discharge rate (4,500 tpd increase)
7-Feb-2002	Approval to discharge effluent from the Perimeter Embankment Seepage Collection Pond (PESCP) and Main Embankment Seepage Collection Pond (MESCP); approval to store TSF supernatant and Mine site contact water in the Cariboo and Bell Pits
4-May-2005	Amended authorized tailings discharge rate (5,000 tpd increase); discharge of groundwater to Polley Lake; updates to reference analytical procedures and monitoring program
17-Apr-2009	Amended monitoring, water level and supernatant characteristic requirements for the Cariboo and Bell Pits
7-Nov-2012	Approval to discharge to Hazeltine Creek
7-Jun-2013	Sulphate guidelines
9-Jul-2015	Tailings discharge to the Springer Pit
29-Nov-2015	Approval to discharge to Hazeltine Creek
4-Apr-2016	Discharge of additional tailings to the Springer Pit
9-Sep-2016	Hazeltine Creek discharge total suspended solids limit change
7-Apr-2017	Direct pipeline from water treatment plant to Quesnel Lake
2-Oct-2018	Amendment to sections 1.2.3, 1.2.6, 2.7 of existing permit (Appendix A)

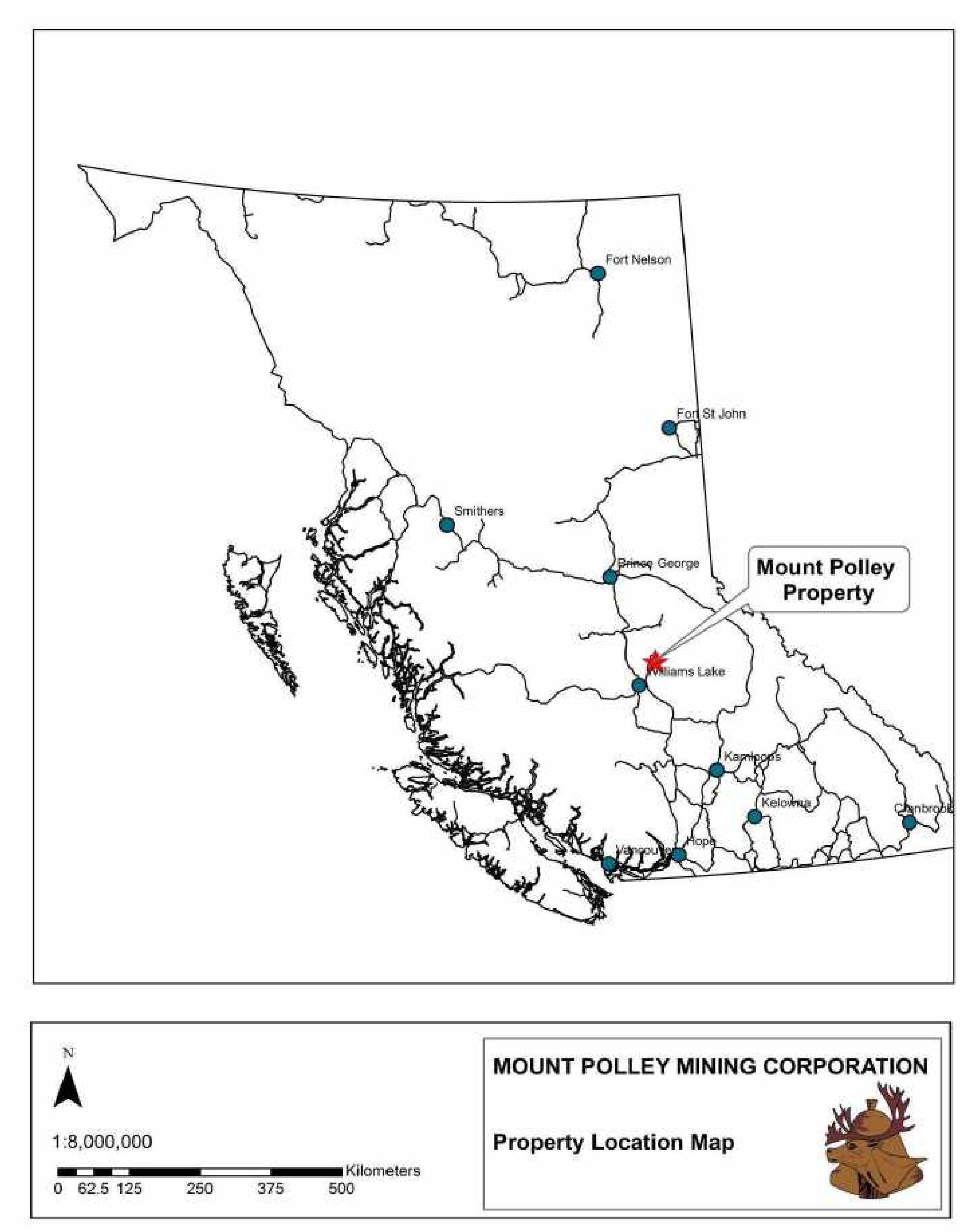

Figure 2.1 Mount Polley Mine property location

2.1.1 Tailings Storage Facility Embankment Breach

On August 4, 2014, a breach occurred in the Perimeter Embankment of the TSF; this event is herein referred to as the "TSF embankment breach". The TSF embankment breach released tailings, water, and embankment construction materials to the downstream environments of Polley Lake, Hazeltine Creek and Quesnel Lake. The ENV issued MPMC *Pollution Abatement Order (PAO*) 107461, dated August 5, 2014, ordering MPMC to attend to the environmental impacts of the TSF embankment breach. As of December 31, 2017, the *PAO* remains in effect and MPMC continues to meet its requirements.

2.1.1.1 Post TSF Embankment Breach Reporting

Following the TSF embankment breach, an environmental monitoring program was initiated in areas downstream of the TSF including Polley Lake and Hazeltine Creek, both of which were previously monitored under *EMA* Permit 11678 (Appendix A). Monitoring of these areas in 2014 and 2015 was carried out under the *PAO*; consequently, these monitoring results were presented in the *Post-Event Environmental Impact Assessment Report* (*PEEIAR*; MPMC, 2015a; publicly available online) and *PEEIAR* Version 2 (MPMC, 2016a; publicly available online). Results from monitoring conducted in 2016 were presented *Human Health Risk Assessment* (*HHRA*), (MPMC, 2017b; publicly available online) and *Ecological Risk Assessment (ERA*), (MPMC, 2017c; publicly available online) which have both been approved by ENV. Monitoring results from 2017 are presented the 2017 *AERR*), (MPMC 2018a). A C*RP* was required by the *PAO* to address the remedial actions based on the findings, results, and conclusions on the risk assessments, and will be integrated in the updated *CEMP*. This plan was submitted on January 31, 2018 to ENV. Review comments were received from ENV and government to government committee on December 11, 2018 just prior to consultation meetings with local communities. MPMC will address the comments and move towards finalizing the document. ENV has requested an updated *CRP* be submitted by March 31, 2019.

2.2 Post TSF Embankment Breach Project Status

2.2.1 Mine Operations

Following the TSF embankment breach, mine operations ceased. Restricted operations, with tailings being deposited in the Springer Pit, commenced on August 4, 2015. On November 6, 2015, MPMC applied for an amendment to *Mines Act* Permit M–200 to allow for the return to full operations at the Mount Polley Mine, with use of the TSF for tailings deposition. A corresponding *Mines Act* Permit M–200 amendment was received from the EMPR on June 23, 2016. Authorization to resume deposition of tailings in the TSF under *EMA* Permit 11678 was received from the ENV on June 23, 2016. MPMC resumed deposition of tailings in the TSF on June 27, 2016.

Currently authorized operations allows for: open pit mining of the Phase 4 Cariboo-Springer Pit; milling of up to a maximum of 8,200,000 t of ore per year with deposition in the TSF; and, construction and operation of the TSF up to an elevation of 970 metres above sea level (masl).

The current active project infrastructure consists of the mill site, mining in the Cariboo Pit, two (2) rock disposal sites (RDS) (the Southeast Rock Disposal Site (SERDS), and the Temporary Northwest (NW) Potentially-Acid Generating (PAG) Stockpile), the TSF, as well as access roads, power lines, a tailings pipeline, drainage collection systems, and sediment/seepage control ponds. The Boundary Zone Pit, the Pond Zone Pit, the Southeast Zone (SEZ) Pit, the Bell Pit, and the Springer Pit are not currently active due to dredging operations. Back-filling of the Bell Pit and Pond Zone Pit with waste rock was completed in 2012, and the SEZ Pit was backfilled in 2013. A detailed Mount Polley Mine site map is included in Appendix B.

No permits for operation beyond the Phase 4 Cariboo-Springer Pit development are in place; however, identified ore reserves indicate approximately eight (8) more (cumulative) years of viable mine life. Given the uncertainty around future operations and mine life, reclamation and closure planning described in this document are subject to review and updates.

Next year's production is projected to end with the mill shut-down as part of a Care and Maintenance program that will go into effect May 31, 2019. Low copper prices are cited as the reason for this action. Between January and May 2019, mill feed will be provided by stockpiled ore. Mining will resume once economic conditions improve. The environmental monitoring and remediation work programs will continue in 2019. The current permitted projected date of Mine closure is 2022.

2.3 Environment

2.3.1 Topography and Climate

The Mount Polley Mine property is located on the eastern edge of the Fraser Plateau physiographic sub- division, characterized by rolling topography and moderate relief. Elevations range from 920 masl at Polley Lake to 1266 masl at the summit of Mount Polley. Volcanic rocks general underlay this part of the plateau with inclusions of intrusive rocks. Most of the area is covered by a deposit of unconsolidated till which contains fluvial, lacustrine, and colluvial deposits. Some patches of organic soils are present in poorly drained areas (i.e., wetlands). The property is located in an alkali porphyry copper-gold deposit hosted in the Central Quesnel Belt along the Intermontaine Belt of BC.

The site is located within the Interior Cedar Hemlock biogeoclimatic zone. Local forests consist of western red cedar, Douglas-fir, hybrid spruce, and subalpine fir, with a lesser presence of trembling aspen, black cottonwood, and paper birch. Much of the area was historically harvested in commercial logging operations and is also used for cattle grazing.

Average annual precipitation in the study area is 635 millimetres (mm). Precipitation typically occurs as snowfall from November through March, with an average maximum of snowpack of 178 mm snow water equivalent occurring at the end of March (Golder 2015a). Average monthly temperatures at the Mount Polley Mine range from -5.9 degrees Celsius (°C) in January to 15.5 °C in July and August (Section 5.3.2). Prevailing winds are from the north-north-east and from the south-south-west near the TSF, and from the northwest (and to a lesser extent the southeast) near the mill, with a predominance of winds designated as calm (below 3 metres per second;

Golder 2015a).

2.3.2 Hydrogeology

The groundwater flow at the site occurs primarily in the bedrock units in response to recharge from precipitation in the area between Polley Lake and Bootjack Lake. Flow in the overburden is less significant due to its limited thickness and discontinuous nature. Prior to mining, the water table at the site generally followed the surface topography, but the water table was deeper below the topographic heights and shallower in the low areas. At that time, the direction of groundwater flow was inferred to be from the top of the ridge between Polley Lake and Bootjack Lake towards the low-lying areas associated with these lakes northeast and southwest from the ridge.

Mine dewatering has altered the groundwater flow pattern at the site, with the open pits and underground workings acting as sinks for groundwater flow. Mine dewatering lowered the water table elevation and created radial patterns of groundwater flow towards these facilities. In 2018, Springer Pit water levels continued to be drawn down by dredging. Near the end of 2018, when dredging operations ceased, water levels became static and remained static the rest of 2018. The currently available information suggests that some seepage from the lake towards Bootjack Lake could occur once the Springer pit lake level reaches 1020 to 1030 masl elevation (Golder 2015a).

3 Environmental Management

3.1 Water Management

A map of all drainages and watersheds around the Mount Polley Mine site is provided in Appendix B. Further information regarding pre-mining drainage and watershed can be found in the *RCP* (MPMC, 2017a). The water management system allows all flow up to a 1 in 10 year 24 hour storm event, and withstand all flows up to a 1 in 200 year 24-hourstorm event, without significant damage.

3.1.1 Evaluation of Effectiveness of Water Management

MPMC continually evaluates water management infrastructure through routine inspections to ensure that it performs as expected. In 2018, all water management infrastructure performed as intended even though there were two (2) unintentional releases of mine contact water. The first occurred on September 24 and was deemed a construction oversight. The second release occurred on November 5 from sumps on the west side of the site was due to a heavy precipitation event and snowmelt. The sumps were designed to handle the 1 in 200 year 24 hour storm by overflowing in a controlled matter and not causing any significant damage. As sumps were not damaged. No water from the sumps entered any water bodies. Details of these releases are presented in Table 3.7 and follow-up reports were submitted to ENV.

3.1.2 Water Management System Update

A map of the mine runoff collection and water management system as of the December 31, 2018 is presented in Appendix B. Changes to this system in 2018 include construction of the North East Zone (NEZ) Seep Sump.

3.1.3 Water Discharge Background

MPMC has a positive water balance and the annual surplus of water has increased over the life of the project as the Mine footprint has expanded, necessitating the collection of surface runoff from a larger area. A surplus of water accumulated in the TSF and water was discharged to Edney Creek under *EMA* Permit 11678 during the period in the early 2000's when the Mine was in Care and Maintenance due to low metal prices. In November 2011, MPMC received an amendment to *EMA* Permit 11678 that allowed for discharge of tailings dam filtered water into Hazeltine Creek; however, permit restrictions on the quality and quantity of water to be discharged, discharge season, and water source did not allow MPMC to fully discharge the surplus water that was accumulating in the TSF. At the time of the TSF embankment breach, MPMC was actively pursuing permit amendments for a short-term discharge (reverse osmosis-treated water to Polley Lake, with the process reject stream (brine) stored in the TSF), to manage the surplus of water for a period of approximately three to four years while a *Long-Term Water Management Plan (LTWMP)* was developed.

Following the TSF embankment breach, MPMC had no permitted discharge, and all contact water was being stored in the Springer Pit. However, the Mine site continued to have a positive water balance (Golder 2015a) and the

Springer Pit has a finite capacity. Golder estimated that once the pit water elevation reaches approximately 1,030 masl, the water will exfiltrate to the groundwater and discharge towards Bootjack Lake (Golder, 2015a). At 1,050 masl the Springer Pit will overflow. Therefore, a short-term water management plan was developed following the TSF embankment breach; MPMC applied for and received an amendment to *EMA* Permit 11678 (along with the required supporting permits and authorizations) for a short-term water discharge to be utilized in the interim, while consultation and planning was carried out to develop a long- term water management strategy. The short-term discharge expired on November 30, 2017, at which time the long-term water management strategy was implemented.

Table 3.1 provides a summary of water discharge authorizations from the Mount Polley Mine. The current authorized discharge is discussed in further detail in Section 6.

Table 3.1 Summary of *EMA* Permit 11678 authorizations for water discharge from the Mount Polley Mine

Date	Discharge Source Permitted	Discharge Location	Comments
7-Feb-2002	MESCP	Edney Creek	Discharge discontinued in 2005; no longer permitted.
7-Nov-2012	Dam filtered	Hazeltine Creek	Discharge discontinued in 2014; no longer permitted.
29-Nov-2015	Springer Pit, and site runoff and seepage collection water management systems	Quesnel Lake via Hazeltine Creek	Discharge discontinued in 2017; see Section 6.
30-Nov-2017	TSF, and site runoff and seepage collection water management systems	Quesnel Lake via direct pipeline	Active in 2018; see Section 6

3.1.4 Long-Term Water Management Plan Development

MPMC developed a *LTWMP* in conjunction with the implementation of the short-term water management plan in 2016. Below is a list of the milestones from the *EMA* Permit 11678 amendments (Appendix A), which dictated the timeline for transition to the *LTWMP*.

- An *Alternative Discharge Design and Construction Plan* was due January 31, 2015.
- A draft *Long-term Water Management Strategy Technical Assessment Report* was submitted on June 30, 2016. The final report was submitted October 17, 2016 followed by the submission of the amendment application on October 20, 2016.
- Development and implementation of an alternative to the discharge to Hazeltine Creek is required by November 30, 2017. The April 2017 amendment of the permit required completion by December 31, 2017.
- The short-term water discharge is authorized only for a two-year period, ending November 30, 2017.
- The long-term discharge is authorized until December 2022.
- The pipeline to convey water to Quesnel Lake was the chosen option for the *LTWMP*. The construction

of the pipeline was completed in November 2017.

No changes to the *LTWMP* occurred in 2018 with the exception of the development, submittal, and ultimate approval of the *Annual Discharge Plan (ADP)* required under Section 2.7 of *EMA* Permit 11678. The *ADP* was approved by the ENV on September 6, 2018. An amendment to the *EMA* Permit 11678 was granted by ENV on October 2, 2018 to reflect the ADP (Appendix A).

The 2018 *ADP* is meant to outline, among other items, the expected volume, timing, and quality of effluent released to Quesnel Lake, and plan the discharge in such a manner that avoids "pollution", as defined in *EMA* and as determined by the evaluation of parameter concentrations at the edge of the Initial Dilution Zone (IDZ) in Quesnel Lake. Parameter concentrations at the edge of the IDZ will be monitored using a new, model-based approach as part of a *Trigger Response Plan (TRP)* (Section 6.2.6.2; Appendix H).

As a forward thinking component of long term site water management, passive water treatment studies were initiated in 2018 that included insitu pit lake treatment studies. The focus of this study is to reduce selenium and nitrate levels in the pit lake prior to discharge. Bench scale testing was initiated in 2018. Additional studies involve the evaluation and feasibility of other semi-passive and passive systems including sand filtration, Biochemical Reactors (BCR), Packed Bed Reactors (PBR), and sulphide polishing cells; all designed to reduce Constituents of Concern in mine influenced water. A Constructed Wetlands Treatment System (CWTS) was also built in 2018 that will test whether mine water can be effectively treated through wetlands technology. For all these potential water treatment options, additional work will be carried out in 2019.

As a more active treatment option, design work and bench scale testing was conducted on water that is treated by the Water Treatment Plant as part of the Copper Optimization Study. This study focuses on the use of reducing effluent copper levels by testing different flocculants to settle suspended solids more effectively which will reduce metal concentrations including copper. A pilot scale test will be conducted in 2019.

3.1.5 Water Balance

MPMC retains Golder to maintain a predictive water balance model for the Mount Polley Mine site using GoldSim™ software. This model generates probabilistic flow and water balance forecasts for site water management system components, and has been adapted to model conditions during operations, closure, and post-closure following reclamation work.

The GoldSim™ water balance model is used for planning purposes such as water discharge planning, with calibration and revised projections made based on actual observed site conditions (i.e., water levels and storage volumes). The model also undergoes routine validation through comparison of predicted and observed accumulations, based on actual climate conditions and water management data recorded from site. Model validation was most recently carried out in March 2019 for data covering the period January 2018 to December 2018. Golder provided a *Site Wide Water Balance Model Update and Calibration Technical Memo* and is included in Appendix P.

In addition to the GoldSim™ model developed by Golder, MPMC has an operational spreadsheet that is used to record, and track components of the onsite water balance for operational purposes. Water storage conditions on site for 2018 are summarized in Table 3.2. Under conditions of *Mines Act* Permit M–200 authorizing the return to full operations and use of the TSF, Quantitative Performance Objectives (QPOs) were established. Some of the QPOs are specific to free water storage in the TSF. Under current authorizations, the TSF is operated with a normal operation free water surplus between 1,000,000 m^3 and 1,500,000 m^3, and is authorized for temporary detention of water for contingency (e.g., freshet) storage provided that a minimum freeboard of 1.1 m is maintained.

Under the *EMA* Permit 11678, monthly elevations of the Springer Pit must be recorded on a monthly basis for water balance purposes. Monthly elevations are provided in Table 3.3.

A summary of the water storage conditions is presented in Table 3.2.

Table 3.2 Water storage conditions at end of 2018

Item	**2018 Year End**	**Change from 2017 Year End**
Springer Pit Elevation (masl)	986.96	-17.56
Springer Pit Volume (m^3) - Total	2,854,843.90	-2,197,229.97
Springer Pit Volume (m^3) - Tailings + Interstitial Water	2,537,251.00	-1,072,110.81
Cariboo Pit Water Elevation (masl)	0.00 [(a)]	0.00
Cariboo Pit Water Volume (m^3)	0.00 [(a)]	0.00
TSF Elevation (masl)	961.69	3.23
TSF Volume (m^3) - Total	13,405,222	4,080,246
TSF Volume (m^3) – Tailings + Interstitial Water	12,551,668	5,219,725
Total Free Water Volume (Springer + Cariboo + TSF)	1,171,147	-2,264,598
Total Water Discharged (m^3)	5,265,722	3,246,072

[(a)] Actively mining in Cariboo Pit. Sump being kept as low as practicable.

Table 3.3 Monthly Springer Pit elevations in 2018

Springer Pit elevations (masl)	
1-Jan-18	1004.52
1-Feb-18	1003.67
1-Mar-18	1003.55
1-Apr-18	999.59
1-May-18	995.00
1-Jun-18	990.40
1-Jul-18	987.38
1-Aug-18	987.27
1-Sep-18	986.23
1-Oct-18	986.04
1-Nov-18	986.29
1-Dec-18	987.26

3.1.6 Water Management System Upgrades

MPMC completed and submitted a Water Management Plan and System Review to the EMPR on March 31, 2016, as required under conditions of *Mines Act* Permit M–200. This Water Management Plan and System Review provided an overview of water management planning at the Mount Polley Mine; an update on site works completed since the issuance of the July 9, 2015 *Mines Act* Permit M–200 amendment requiring its development; a review of the design criteria and operational requirements of the water management system, as completed by third party QPs; a summary of the outcomes of the third party review; and, planned work.

Bi-annual sump and ditch inspections (required under *EMA* Permit 11678*)* were completed in 2018, as well as daily water management infrastructure inspections, environmental monitoring, and other observational activities as per MPMC's *Operation, Maintenance and Surveillance (OMS) Manual* (as well as part of MPMC's *Sediment and Erosion Control Plan*; Section 3.2). Golder inspected the Long Ditch (LD) and West Ditch as part of site hydraulic assessments for water balance calibration purposes. Based on inspection results, upgrades and modifications (in addition to routine maintenance) are made to support continuous improvements of the site water management system. No improvements to existing site contact water collection systems were conducted in 2018:

3.2 Sediment and Erosion Control

MPMC maintains a *Surface Erosion and Sediment Control Plan.* As required by the *Mines Act* Permit M-200, the plan was reviewed (but not edited) in 2018 and measures conducted in 2018 as per the plan are summarized in Section 10.3.3 (excluding work being done related to the TSF embankment breach). The plan was submitted to the EMPR in January 2017 as an appendix to the updated *RCP* (MPMC, 2017a).

3.3 Waste Management

3.3.1 Storage

In its mining operations, Mount Polley has utilizes a variety of chemicals, reagents, and other products. At any one time, the approximate volumes of materials in Table 3.4 could be on site.

Table 3.4 Chemicals and reagents stored at the Mount Polley Mine site

Materials	Total Stored	On Hand on Jan 1, 2019
PAX (Mill Reagent)	21,000 kg	21,000 kg
Lime	100,000 kg	61,849 kg
Polyclear 3180M	2,800 kg	1,814 kg
Polyfroth W22C	21,848 kg	21,848 kg
NaHS	482,4000 kg	27,000 kg
Methanol	5,000 L	13,615 L
Vanpress (Coagulant)	-	29,353

Blasting product values shown in Table 3.5 are the maximum allowable limits that may be stored at any given time at Orica Ltd.'s Mount Polley site and a snap shot of what was on hand on January 1, 2019. Orica Ltd. ceased operation at the Mount Polley Mine in the fall of 2018 in preparation for the Mine's pending Care and Maintenance phase. As such, all blasting products have been removed from the site as indicated in Table 3.5.

Table 3.5 Blasting products stored at Orica Ltd.'s Mount Polley site

Blasting Products	Maximum Allowable Limits Stored	On Hand on Jan. 1, 2019
Ammonium Nitrate Emulsion	50 t	0
Ammonium Nitrate Prill	100 t	0
Sodium Nitrite	3000 kg	0
Ethylene Glycol	4000 kg	0

3.3.2 Chemical, Reagent, and Contaminated Waste Disposal

Mount Polley Mine operations utilizes potentially hazardous chemicals, reagents, and other products that are subject to a waste disposal procedures. In 2018, Sumas Environmental Services Ltd. routinely removed and disposed of these waste products in an environmentally safe manner compliant with all relevant waste management legislation. Products removed include: aerosol cans; contaminated gasoline and diesel; waste oil (in drums); waste oil filters; waste grease fuel or oil soaked rags, debris, and floor dry; and leachable liquid toxic waste, such as glycol/anti-freeze mix. The site waste oil tanks are emptied and the oil removed from site by GFL Environmental. In 2018, MPMC collected a total of 132,900 L of waste oil. There were ~ 5,000 L of waste oil on site as of January 1, 2019. MPMC is registered with ENV under the *Hazardous Waste Regulation* (Ministry of Attorney General, 2017) for generation and temporary storage of these materials.

3.3.1 Recycling

MPMC recognizes the value of responsible waste management and recycling plays a big role in site waste management practices. Mount Polley continues to recycle used materials including waste oil, scrap steel, batteries, plastic pails, electronic waste, light bulbs and associated fixtures, paper, cardboard, and beverage containers. In 2018, Mount Polley donated the funds generated by its beverage container recycling program to the Big Brothers and Big Sisters of Williams Lake.

Recycling and waste management educational presentations were given to Mount Polley employees and contractors in Q1 2018. An overview of waste segregation procedures is also presented to all new hires, contractors and visitors during site orientation.

3.4 Incidents

3.4.1 Spills of Hydrocarbon or Dangerous Goods

All spills of hydrocarbons, coolant, and chemicals are reported to the MPMC Environmental Department. In 2018, there were four (4) coolant spills and eleven (11) hydrocarbon spills reported. Of these spills, one (1) was reportable to Emergency Management BC as outlined in the Spill Reporting Legislation (Table 3.6). This spill was given a Dangerous Goods Regulation (DGR) number and recorded in the government database. All spills were cleaned up and the materials were removed from site in environmentally safe barrels by Sumas Environmental Services Ltd.

Table 3.6 Hydrocarbon and Dangerous Goods Spills reported to Environmental Department in 2018

Date & Time Reported	DGR#	Source	Volume (L) (estimated)	Material	Location
25-Jan-2018 12:30		20-031 Excavator	20	Hydraulic Oil	In pit washrooms
26-Jan-2018 1:00		10-012 Drill	40	Coolant	Cariboo Pit 988 Bench
04-Feb-2018 1:00		15-024 Haul Truck	75	Hydraulic Oil	Crusher - Gyro Pocket
05-Feb-2018 15:45		15-019 Haul Truck	5	Coolant	Cariboo Pit Ramp
20-Feb-2018 5:00		992 Lube Truck	20	Diesel Fuel	Fuel Docks
23-Feb-2018 22:45		Oil Storage Seacan	40-50	Hydraulic Oil	Crusher - Bay Door
26-Feb-2018 20:00		20-030 Excavator	25	Hydraulic Oil	#1 Stockpile
02-Mar-2018 17:00		25-001 Stemming Loader	30	Hydraulic Oil	Cariboo Pit 976 Bench
06-Mar-2018 17:00		15-024 Haul Truck	30	Coolant	SERD
28-Aug-2018 23:50		10-014 Drill	40	Compressor Oil	Cariboo Pit 952 Bench
05-Sep-2018 21:50		50-090 Heavy-Duty Truck	50	Diesel Fuel	CCS Ramp
16-Sep-2018 22:23		15-015 Haul Truck	15	Diesel Fuel	Fuel Docks
26-Oct-2018 16:30		15-038 Haul Truck	40	Coolant	Fuel Docks
05-Nov-2018 15:15		15-035 Haul Truck	50	Diesel Fuel	Fuel Docks
25-Nov-2018 14:15	18-3063	40-085 Grader	121.5	Hydraulic Fluid	Landfill

3.4.2 Water Releases

In 2018, there were two (2) releases of mine-affected water. Notifications and follow up reports were submitted to ENV and a summary is provided in Table 3.7.

Table 3.7 Release of mine influenced water reported to the ENV in 2018

Date Reported	Source	Volume (m^3)	Material	Location
24-Sept-18	Corner 1 buttress ditch	Unknown	Mine Contact Water	Polley Flats
5-Nov-18	Junction Zone Sump, 9k Sump, NW Sump, Mine Drainage Sump	Unknown	Mine Contact Water	Designated spillways/ overflows

4 Data Quality Assurance/Quality Control

The purpose of the data quality assurance/quality control (QA/QC) program is to verify the reliability of monitoring data through the implementation of procedures for controlling and monitoring the measurement and analysis process. The QA/QC program provides information for evaluation of the analytical and monitoring procedures, and identification of issues pertaining to possible contamination, both in the field and in the analytical laboratory. The QA/QC program includes:

- Quality assurance (QA): management and technical practices designed to confirm that data were consistent with the objectives of the water quality program
- Quality control (QC): specific data quality objectives (DQOs), statistical assessment of data quality, and corrective measures taken whenever the DQOs were not met

The QA/QC program is conducted at all stages of the sampling program: sample collection, transport, and analysis for all sites including contact water quality sites, surface water quality sites, lakes, and groundwater wells.

MPMC maintains a *Quality Assurance/Quality Control Manual* (most recent version: MPMC, 2017d; herein referred to as the "*MPMC QA/QC Manual*" that is reviewed and audited annually. This manual oversees all the standard operating procedures and work methods pertaining to monitoring and sampling activities on the Mount Polley Mine site.

4.1 Environmental System Audits

Environmental management plans (EMP) are based on the requirements set out by the *EMA* Permit 11678 and *Mines Act* Permit M–200 and are scheduled for updating and submitting accordingly. The following EMP were reviewed and updated in 2018:

- *Environmental Emergency Response Plan*
- *Hazeltine Creek Fish Exclusion Plan*
- *Annual Discharge Plan*
- *Sediment and Erosion Control Plan*
- *Invasive Pant Management Plan*
- *Dust Management Plan*
- *CEMP*

4.2 Scheduling

To coordinate sampling and schedule all planned monitoring, as per the *CEMP* and to be compliant with all applicable regulations MPMC prepares internal monthly sampling schedules.

4.3 Field Methods

4.3.1 Sample Collection

Sample collection was consistent with the procedures described in the current *British Columbia Field Sampling Manual: 2013 – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (ENV, 2013) and *MPMC QA/QC Manual* (MPMC, 2017d). Monitoring procedures for the discharge locations (see Section 6) were consistent with the *Metal Mining and Diamond Effluent Regulations* (Environment Canada, 2017), as appropriate.

4.3.2 Sample Suites

Each full sampling suite for water chemistry analysis consists of a variety of bottles. As outlined in Table 4.1, the type and volume of bottle will depend on the analysis and is determined by the *BC Field Sampling Manual* (ENV, 2013) and laboratory criteria (Section 4.4). In 2018, the full sampling suite for surface and lake water chemistry consisted of six (6) bottles: Nutrients- 1, TSS, total ammonia and nitrogen, dissolved organic carbon, total metals and dissolved metals bottles. The full sampling suite for groundwater chemistry consisted of three (3) bottles: Nutrients-2, total ammonia and nitrogen and dissolved metals (Table 4.2).

Table 4.1 MPMC full sampling suite

Type and volume of bottle	Name of analysis	Type of analysis
500 mL clear plastic bottle	Nutrients-1 (surface and lake water)	pH, conductivity, turbidity, total dissolved, solids, hardness, alkalinity, chloride, fluoride, sulphate, phosphorus total and dissolved, and ortho-phosphorus
	Nutrients-2 (groundwater only)	pH, conductivity, hardness, alkalinity, chloride, fluoride, sulphate, phosphorus total and dissolved
	TSS	Whole bottle TSS
120 mL amber bottle	Total ammonia and nitrogen	Total nitrogen, nitrate, nitrite, ammonia
	Dissolved organic carbon	Dissolved organic carbon
60 mL plastic bottle	Total metals Dissolved metals	See CEMP (Appendix A) See CEMP (Appendix A)

4.3.3 Field Meters and Monitoring Equipment

Field meters were used to measure dissolved oxygen, conductivity, pH, temperature, turbidity, and water flow. Meters and other field equipment were operated and calibrated following the manufacturers' instructions and the MPMC QA/QC Manual, which includes specific work methods for the equipment discussed below.

The conductivity and pH meters used for field analysis of surface water and groundwater were the WTW pH/Conductivity 340i and 3430 handheld multimeters. In situ turbidity was measured with LaMotte 2020e and 2020we turbidity meters. For measuring field parameters in lakes, YSI EXO multimeters were used. Calibration records were recorded in the calibration logbook, as outlined in the *MPMC QA/QC Manual* (MPMC, 2017d). The YSI EXO multimeter was operated based on the equipment manual and guidance from the supplier (Hoskin Scientific), with general MPMC calibration practices being followed.

Flow measurements were taken using a Sontek FlowTracker Acoustic Doppler Velocimeter. The user measures flow rates across a creek or ditch cross section using the FlowTracker handheld device and the device then calculates the discharge rate based on these measurements and input parameters. The meter has QA/QC standards programed into it, and the device provides error notifications if these standards are not met. An International Organization for Standardization and statistical U.S. Geology Survey percent error are calculated for each discharge reading based on depth, velocity, width, method, number of stations, and calibration accuracy to evaluate accuracy of the discharge measurement. The dry salt slug injection tracer method was used by WaterSmith during benchmarking surveys and station assessments in August 2017 and was subject to WaterSmith's QA/QC procedures.

The staff gauge benchmarking (calibrating) and hydrology station calibrating program occurs annually as required by Section 3.4 of *EMA* Permit 11678 and as per protocol in the *MPMC QA/QC Manual* (MPMC, 2017d). Station specific details are provided in Sections 7.10 and 8.3.

Field Secchi disk monitoring was undertaken in the lakes (Section 8.6.2; Appendix L).

Chlorophyll *a*, phytoplankton and zooplankton samples were collected as per the protocol in the *MPMC QA/QC Manual* (MPMC, 2017d). Chlorophyll *a* and zooplankton tissue metals analysis were sent to ALS (see Section 4.4). Enumeration and species identification of phytoplankton community and zooplankton taxonomy samples were sent to specialized labs (Section 4.4) as described in the CEMP (Appendix A).

4.4 Quality Control and Data Quality Objectives

Analytical processing of samples collected by MPMC is conducted by ALS Environmental (ALS) in Burnaby, BC. ALS is a Canadian Association for Laboratory Accreditation Inc. accredited laboratory for the analyses requested. The Laboratory DQOs provided to MPMC by ALS are included in Appendix D.

Bioassay (toxicity) testing is carried out by Nautilus Environmental (Nautilus) in Burnaby, BC. Nautilus is Canadian Association for Laboratory Accreditation Inc. accredited laboratory for the analyses requested. Acute and chronic bioassays methods are conducted as outlined in the *Metal and Diamond Mining Effluent Regulations (MDMER) Environmental Effects Monitoring* (*EEM*) studies and *EMA* Permit 11678 requirements. The toxicity tests are scheduled 30 days prior to sampling as required by *MDMER* (see Section 6.3). The laboratory QA/QC measures provided to MPMC by Nautilus are included in Appendix D.

Phytoplankton from Polley and Quesnel Lakes were sent to Planktons R Us Inc. in Winnipeg, Manitoba. Zooplankton taxonomy samples from Polley and Quesnel Lakes were sent to Fraser Environmental Services Ltd. in Surrey, BC. Previous samples from Quesnel Lake were sent to Mary-Jane Hudson in Nanaimo, BC to align with the Department of Fisheries and Oceans (DFO)'s operating procedures; however Ms. Hudson has since retired.

Samples submitted were tracked to verify that laboratory sampling and analysis protocols were followed, including hold times, sample containers, preservatives, detection limits, and approved methodology. Instances in which these protocols were not followed were recorded in the sample tracking spreadsheet. This spreadsheet tracked individual samples and recorded the locations of samples, along with the date, duplicate and blank sample information, sample shipping information, laboratory correspondence, analytical results, and potential data integrity issues.

4.4.1 Replicates and Blanks

For water chemistry, QC samples were collected as a component of the monitoring program as per the MPMC QA/QC Manual. The recommended minimum number of replicates and blanks is 10% of the overall samples as set out by the current *BC Field Sampling Manual* (ENV, 2013). In 2017, MPMC achieved 13% of total QC samples. In 2018, MPMC achieved 12% of total QC samples. A combined QC schedule across the various MPMC monitoring programs as described in the *CEMP* is summarized in Table 4.2.

Table 4.2 Water chemistry QC sample frequencies for MPMC monitoring programs

QC Samples	Minimum Frequency
Duplicate samples	2 per month/10% of samples
Equipment blanks	Monthly/Quarterly per piece of equipment (when used)
Trip blanks	2 per month
Field blanks	2 per month
Filter blanks	Quarterly
Deionized (DI) water blanks	Annually
Inter-laboratory replicate	Annually

4.4.1.1 Field Replicates

The semi-blind replicates are intended to evaluate the QA/QC surrounding the sampling methods. Replicates are prepared by collecting two full sample suites from one location at the same time, one after the other, labelling one with the sampling location name (e.g., E4, HAC-13) and labelling the second sample suite with a replicate name (e.g., ED, HAC-M). When the results are reported back from the analytical laboratory, all parameters from the replicate and the actual sample are screened to confirm likeness, or potential of sampling error or contamination. The screening process also considers accuracy of the analytical procedures and small-scale natural variations in water quality which may occur over the timescale of collection (approximately 10 minutes). In particular, there is considerable potential for variations in water quality over short-time scales during periods of high sediment loads.

Semi-blind field replicates were compared to evaluate the precision of the methods used (i.e. combined precision of field methods, laboratory methods and the environmental variability between the side-by-side samples). A relative percent difference (RPD) is calculated to identify significant differences between the replicate and sample, where the RPD (as %) can be defined as:

$$\text{RPD }(\%) = \frac{|X_x - X_y|}{\bar{X}} \times 100$$

Where X_x = the concentration of the original sample
X_y = the concentration of the blind field duplicate sample
$\bar{X}$ = the average of the original and duplicate samples

The acceptance criteria for RPDs for water chemistry are defined as 1.5x the laboratory RPD criteria, which is summarized in Table 4.3. For results less than five times the detection limit, significant differences are identified if the difference of the two results is greater than twice the detection limit. When either sample is less than detection limit, differences are not calculated.

Table 4.3 Duplicate Sample RPD acceptance criteria

Analyte Group	RPD Acceptance Criterion
Metals	30%
Inorganics	30%
Organics	45%
Other parameters	1.5 x Laboratory RPD

There were seventy-eight (78) field replicate samples collected in 2018, as shown in Table 4.4. The raw data are available in Appendix D. Note the prefixes refer to location areas (ie. 'W' refers to non-contact water site, 'EDC-01', refers to Edney Creek); additional information on naming conventions are found in the *CEMP* (Appendix A). There were no results for total metals analysis for the groundwater duplicates (e.g. GW15-2a) as total metals are not analyzed for groundwater samples. In addition, the BAC samples (eg. BAC-01) are only analyzed for E-coli and total bacteria coliform. All results above the respected RPDs were rechecked by ALS.

Table 4.4 Field replicate sample locations collected in 2018.

Date Sampled	Location	Name
2-Jan-18	BAC-01	BAC-A
3-Jan-18	W4a	WDa
8-Jan-18	E19	ES
8-Jan-18	HAD-03	HAD-C
16-Jan-18	HAC-13	HAC-M
31-Jan-18	QUL-58-MP	QUL-EH-MP

Date Sampled	Location	Name
6-Feb-18	HAC-01c	HAC-Ac
6-Feb-18	HAC-10	HAC-J
6-Feb-18	POF-1	POF-A
21-Feb-18	E1a	EAa
21-Feb-18	W8	WH
13-Mar-18	P2-B	PB-B
14-Mar-18	HAC-08	HAC-H
14-Mar-18	HAC-05a	HAC-Ea
14-Mar-18	W10	WJ
19-Mar-18	GW16-6a	GWP-Fa
20-Mar-18	W1	WA
3-Apr-18	HAC-01c	HAC-Ac
3-Apr-18	POF-1	POF-A
3-Apr-18	HAD-03	HAD-C
10-Apr-18	BAC-02	BAC-B
11-Apr-18	GW16-2a	GWP-Ba
16-Apr-18	GW96-4a	GWIF-Da
19-Apr-18	QUR-11	QUR-K
25-Apr-18	W5	WE
1-May-18	HAC-13	HAC-M
1-May-18	HAC-14	HAC-N
1-May-18	EDC-01	EDC-A
3-May-18	QUL-58-B	QUL-EH-B
7-May-18	E1a	EAa
17-May-18	B1-B	BA-B
17-May-18	W20	WT
23-May-18	QUL-18-20m	QUL-R-20m
31-May-18	MW17-04	MWQ-0D
5-Jun-18	W10	WJ
5-Jun-18	EDC-01	EDC-A
12-Jun-18	P1-5m	PA-5m
26-Jun-18	GW96-3a	GWIF-Ca
27-Jun-18	QUL-2a-60m	QUL-Ba-60m
4-Jul-18	W4a	WDa
17-Jul-18	BAC-03	BAC-C
2-Aug-18	HAC-10	HAC-J
7-Aug-18	W12	WL

Date Sampled	Location	Name
7-Aug-18	E19	ES
15-Aug-18	GW12-2a	GWL-Ba
21-Aug-18	P2-15m	PB-15m
27-Aug-18	QUL-120a-120m	QUL-ATa-120m
28-Aug-18	B2-16m (B)	BB-16m (B)
4-Sep-18	HAC-05a	HAC-Ea
4-Sep-18	QUL-58-40m (BT)	QUL-EH-40m (BT)
20-Sep-18	W1	WA
2-Oct-18	HAD-03	HAD-C
2-Oct-18	GW16-8	GWP-H
2-Oct-18	GW16-7	GWP-G
2-Oct-18	HAC-01c	HAC-Ac
3-Oct-18	Martel Sump DSR	Martel Sump 41918
3-Oct-18	W5	WE
10-Oct-18	E23	EW
17-Oct-18	NEZ Seep 2	NEZ Seep B
17-Oct-18	QUL-18-0m	QUL-R-0m
22-Oct-18	P1-29m (B)	PA-29m (B)
23-Oct-18	BAC-04	BAC-D
5-Nov-18	GW11-2a	GWK-Ba
5-Nov-18	E15	EO
6-Nov-18	HAD-03	HAD-C
6-Nov-18	HAC-08	HAC-H
7-Nov-18	QUL-58-AT	QUL-EH-AT
7-Nov-18	W8z	WHz
7-Nov-18	E22	EV
8-Nov-18	NEZ Seep 2a	NEZ Seep Ba
19-Nov-18	P2-S	PB-S
21-Nov-18	GW12-5a	GWL-Ea
21-Nov-18	GW96-2a	GWIF-Ba
3-Dec-18	E1a	EAa
3-Dec-18	W4a	WDa
4-Dec-18	NEZ Seep 1	NEZ Seep A
4-Dec-18	HAC-13	HAC-M
4-Dec-18	E19	ES

For total metal analyses, the applicable replicate criterion was exceeded on by:

- Seven (7) occasions for aluminum (five (5) RPDs ranging from 30.3% to 66% and two (2) significant differences of 0.0073 mg/L and 0.0077 mg/L).

- Eight (8) occasions for lead (six (6) RPDs ranging from 35.1% to 77.7% and two (2) significant differences of 0.000115 mg/L and 0.000202 mg/L).
- One (1) occasion for iron (RPD = 73%).
- Two (2) occasions for manganese (RPDs= 31.7% and 38.9%).
- Two (2) occasions for zinc (RPDs =34% and 39%).

Total metal comparisons are available in Table 1 of Appendix D. There are twenty-two (22) exceedances of the applicate replicate criterion for total metals in 2018. This is a substantial increase compared to the seven (7) from 2016 and 2017. However, 2016 and 2018 have the same 22% percent of results that did not meet the replicate criteria, while 2017 retained only 10%. Note that there is some degree of variability that can be expected in replicate samples for parameters such as total metals, which are influenced by total suspended solids (TSS).

For dissolved metals analyses, the applicable replicate criterion was exceeded on one (1) occasion for aluminum (RPD = 46.7%), lead (significant difference = 0.000111 mg/L), cadmium (significant difference = 0.000026 mg/L), and zinc (RPD = 120%). On three (3) occasions, manganese exceeded the replicate criterion and were less than five times the detection limit and the significant differences ranged from 0.00021 to 0.00072 mg/L. All replicate comparisons are available in Table 2 of Appendix D. Comparatively, 2017 and 2018 have the same 9% while 2016 has 16% of its replicates that did not meet the replicate criteria, while 2017 retained only 10%.

For general parameters (ammonia, nitrate, nitrite, sulphate, and TSS), the applicable replicate criterion was exceeded on two (2) occasions for TSS (RPD = 67.5% and 122.3%) and three (3) significant differences were identified for ammonia (ranging from 0.0102 mg/L to 0.0177 mg/L) (Table 3, Appendix D).

For E-coli and total coliform analysis, no differences were identified between samples. All results were below detection limit (Table 4, Appendix D).

There was one (1) inter-laboratory replicate collected in 2018. This replicate is intended to evaluate the QA/QC surrounding the analytical laboratory. This replicate was prepared as described above; the sample with the sampling location name is sent to ALS and the sample with the anonymous name is sent to Maxxam Analytics Inc. (Maxxam) in Burnaby, BC. Maxxam is also a designated Canadian Association for Laboratory Accreditation Inc. accredited laboratory for the analyses requested.

The applicable replicate criterion was exceeded for turbidity (at 8x times the detection limit) and for dissolved aluminum (RPD= 83.6 %). The dissolved aluminum difference exceeded five times the detection limit. (Table 5, Appendix D).

4.4.1.2 Blanks

Trip/travel blanks and field blanks, prepared by the analytical laboratory, do not contain the variables to be analyzed. The blanks are exposed to the same conditions and treatments as the water samples collected and are intended to monitor contamination that may occur during sampling or shipping. Field blanks are opened and preserved at a sample location to expose them to the natural environment and trip blanks remain closed at all times. Trip blanks are not opened and are pre-preserved and are submitted to the laboratory with sample sets for total suspended solids, total metals, and nutrient and anion analysis, as well as dissolved organic carbon analysis for field blanks.

4.4.1.2.1 Trip Blanks

In 2018, twenty (26) trip blanks were submitted to ALS, as listed in Table 4.5.

Table 4.5 Trip blanks sent for analysis in 2018

Date Sampled	Area
8-Jan-18	Mine Site
6-Feb-18	Hazeltine Creek
20-Feb-18	Mine Site
13-Mar-18	Polley Lake
14-Mar-18	Mine Site
12-Apr-18	Mine Site
7-May-18	Mine Site
23-May-18	Quesnel River
7-Jun-18	Mine Site
24-Jun-18	Mine Site
4-Jul-18	Mine Site
19-Jul-18	Mine Site
25-Jul-18	Quesnel Lake
2-Aug-18	Hazeltine Creek
22-Aug-18	Mine Site
28-Aug-18	Bootjack Lake
19-Sep-18	Quesnel Lake
20-Sep-18	Mine Site
27-Sep-18	Mine Site
4-Oct-18	Mine Site
10-Oct-18	Mine Site
7-Nov-18	Mine Site
8-Nov-18	Mine Site
19-Nov-18	Polley Lake
3-Dec-18	Mine Site
4-Dec-18	Hazeltine Creek

Alkalinity, total nitrogen, total barium, total iron, total lead, total manganese, and total tin were above detection limits in one (1) or more of the trip blanks (Table 6, Appendix D). Total nitrogen, total barium and total manganese were greater than five times the detection limit; results are provided in Table 4.6.

Table 4.6. Summary of trip blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
8-Jan-18	Total Manganese (mg/L)	0.00010	0.00060
24-Jun-18	Total Nitrogen (mg/L)	0.030	1.28
19-Jul-18	Total Barium (mg/L)	0.000050	0.00032
8-Nov-18	Total Nitrogen (mg/L)	0.030	0.915

The trip blank parameters that are above detection limit were rechecked by ALS laboratory. A code is associated with the parameters in the ALS results spreadsheet to indicate that the result was rechecked and verified.

4.4.1.2.2 Field Blanks

Twenty-seven (27) field blank listed in Table 4.8 were submitted to ALS in 2018. Alkalinity, turbidity, total phosphorus, dissolved organic carbon, total barium, total cadmium, total iron, total manganese, and total tin were above detection limits in one (1) or more of the field blanks. These results were within five times the reported detection limit so was determined not to affect the reliability of the data except for total manganese, which was greater than five times the detection limit in one (1) instance (Table 4.7). (Table 7, Appendix D).

Table 4.7 Summary of field blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
9-Jan-18	Total Manganese (mg/L)	0.00010	0.00073

The field blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the ALS results spreadsheet to indicate that the result was rechecked and verified. Investigations for the parameters above detection limit are on-going.

Table 4.8 Field blanks sent for analysis in 2018

Date Sampled	Area
8-Jan-18	Mine Site
9-Jan-18	Hazeltine Creek
6-Feb-18	Hazeltine Creek
20-Feb-18	Mine Site
14-Mar-18	Edney Creek
14-Mar-18	Mine Site
3-Apr-18	Mine Site
12-Apr-18	Mine Site
7-May-18	Mine Site
17-May-18	Bootjack Lake
7-Jun-18	Mine Site
27-Jun-18	Quesnel Lake
28-Jun-18	Mine Site
4-Jul-18	Hazeltine Creek
4-Jul-18	Mine Site
15-Jul-18	Mine Site
7-Aug-18	Mine Site
21-Aug-18	Polley Lake
17-Sep-18	Mine Site
20-Sep-18	Mine Site
4-Oct-18	Mine Site
18-Oct-18	Mine Site
22-Oct-18	Polley Lake
6-Nov-18	Hazeltine Creek
7-Nov-18	Mine Site
3-Dec-18	Mine Site
4-Dec-18	Mine Site

4.4.1.2.3 Filter Blanks

Filter blanks are prepared by filtering deionized water and submitting it for dissolved metals analysis. This tests for potential sample contamination during in-field filtering of dissolved metals samples. Four (4) filter blanks were submitted in 2018. All parameters analyzed in the filter blanks were below reported detection limits except dissolved barium from August 2, 2018 (Table 8, Appendix D).

4.4.1.2.4 De-ionized Water Blanks

Deionized water blanks are prepared by submitting a full sample suite (minus dissolved metals since filter blanks are prepared) of deionized water. Two (2) deionized water blanks were submitted in 2018; all parameters were below reported detection limit as expected (Table 9, Appendix D).

4.4.1.2.5 Equipment Blanks

Equipment blanks are collected to test for potential sample contamination being introduced from sampling equipment. When conducting lake water quality sampling, an equipment blank sample is taken with the Kemmerer (KEM1 or KEM 2) sampler monthly during each sampling program. When groundwater samples are collected within the quarter according to the 2018 *CEMP* starting November 9, 2018, an equipment blank will be collected. MPMC has two groundwater pumps: Grundfos (GW-Grundfos) and Low-flow (GW Low-Flow). Equipment blanks (KEM 1 or KEM 2) are submitted to the laboratory for full sample suites for lake quality sampling (minus dissolved metals since filter blanks using syringes are also prepared); while groundwater equipment blanks (GW-Grundfos and/or GW Low-Flow) are submitted for physical tests, anions and nutrients and dissolved metals.

Eleven (11) Kemmerer equipment blanks were taken in 2018, as shown in Table 4.9. One (1) monthly blank was missed in May 2018. KEM 2 replaced KEM 1 in October 2018.

Table 4.9 Equipment blanks taken in 2018

Date Sampled	Equipment
24-Jan-18	KEM1
22-Feb-18	KEM1
21-Mar-18	KEM1
19-Apr-18	KEM1
13-Jun-18	KEM1
2-Jul-18	KEM1
28-Aug-18	KEM1
11-Sep-18	KEM1
18-Oct-18	KEM2
7-Nov-18	KEM2
20-Dec-18	KEM2

Turbidity, total ammonia, total phosphorus, total aluminum, total barium, total lead, total manganese, and total strontium were all above detection limits in one (1) or more of the equipment blanks (Table 10, Appendix D). A summary of results for the KEM blanks that are greater than five times the detection limit is provided Table 4.10.

Table 4.10 Summary of KEM1 blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
24-Jan-18	Total Lead (mg/L)	0.000050	0.000296
22-Feb-18	Total Lead (mg/L)	0.000050	0.000324
11-Sep-18	Total Lead (mg/L)	0.000050	0.00124

The equipment blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the results spreadsheet to indicate that the result was rechecked and verified. Investigations for total lead results above detection limit are ongoing; however preliminary conclusions identify KEM 1 as a possible source of contamination. It has since been replaced by KEM 2 and it has not had any parameters above detection limit.

Two (2) groundwater equipment blanks were taken in 2018, as shown in Table 4.11. Both groundwater pumps were used in the last quarter of 2018.

Table 4.11 Summary of groundwater equipment blanks

Date Sampled	Equipment
10-Dec-18	GW-Low Flow
10-Dec-18	GW-Grundfos

Conductivity, hardness, total phosphorus, dissolved aluminum, dissolved arsenic, dissolved barium, dissolved calcium, dissolved copper, dissolved magnesium, dissolved manganese, dissolved molybdenum, dissolved silicon, and dissolved strontium were all above detection limits in one (1) or more of the equipment blanks (Table 10, Appendix D). A summary of results for the GW-Grundfos blank that are greater than five times the detection limit is provided in Table 4.12.

Table 4.12 Summary of GW-Grundfos blank results that are 5x detection limit

Date Sampled	Parameter	Detection Limit	Result
10-Dec-18	Hardness as $CaCO_3$ (mg/L)	0.50	4.72
10-Dec-18	Dissolved Barium (mg/L)	0.00010	0.00135
10-Dec-18	Dissolved Calcium (mg/L)	0.050	1.32
10-Dec-18	Dissolved Manganese (mg/L)	0.00010	0.00265
10-Dec-18	Dissolved Strontium (mg/L)	0.00020	0.0159

The equipment blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the results spreadsheet to indicate that the result was rechecked and verified. The Grundfos was a rented from a scientific equipment company; even though it was cleaned prior to use and collecting the blank sample, traces of contaminants may have been present.

4.5 Data Quality Review and Data Management

A data quality review was conducted for results, including screening of laboratory QA/QC data, sample integrity issues, detection limits achieved, and metadata accuracy, as well as potential outliers/extreme values. This information was catalogued in the MPMC sample tracking spreadsheet described in Section 4.4.

MPMC uses the MonitorPro (MP-5 database) by EHS Data Limited for data management: soil, sediment, and tissue chemistry data were uploaded to separate MP-5 databases prior to the cyberattack and the data are now currently managed via spreadsheets and filed on the MPMC network. After the cyberattack, the MP-5 database responsible for water chemistry samples and in situ parameters was rebooted and water chemistry data using files generated by the analytical laboratory, as well as weather station downloads were uploaded into the MP-5 database. Accompanying field data were manually entered and uploaded into the MP-5 database. Original laboratory-produced results files are filed on the MPMC network according to location, and date, and are linked to the data stored in the MP-5 database. Sample names, dates, and times are cross-referenced with the MPMC sample tracking sheet before final upload to the database and field data undergo a QC screening prior to upload. Parameter restrictions are in place in the MP-5 database to reduce the likelihood of a typographical or laboratory reporting error being uploaded. Any errors identified by the MP-5 database underwent further audit before final acceptance.

Non-chemistry data, including toxicity testing results, benthic invertebrate and plankton taxonomy data, and hydrology data (logger downloads and FlowTracker exports) are filed according to year and sample location on the MPMC network.

4.5.1 Rating Curve Development

Stage-discharge rating curves were developed for the hydrometric stations by relating manual water level and stream discharge measurements acquired by MPMC (velocity-based measurements using a SonTek FlowTracker) and WaterSmith (dry salt slug injection tracer method [Hudson and Fraser, 2005]). The rating curves were fit statistically [R Development Core Team, 2010] using a nonlinear least-squares regression model of the following generic form:

$$Q = 10^{(a + b \log10(H - c))}$$

where

- Q is discharge, m^3/s,
- H is stage (m),
- a, b, and c are regression coefficients.

Vented pressure transducers (model INW PT2x) were installed at various sites to continuously monitor water level at 10-minute intervals during non-freezing months. According to the manuals, INW PT2x sensors maintain a sensor accuracy of ±0.25% (Seametrics 2016). A linear relation was developed between the automatically recorded pressure and the manual staff gauge readings at each station. Stage values estimated from the pressure readings using the stage-pressure relation were then be substituted into the rating curve equation to estimate stage-discharge at a 10-minute interval throughout the monitoring season. Any estimation above the highest measured discharge is considered an extrapolation.

Statistical analyses of the manual gauge readings are reported in Sections 7.10 and 8.3 and in Appendix K.

As required by Section 3.4 of the *EMA* Permit 11678*,* calibration measurements (taken by a dry salt slug injection tracer method) and benchmarking surveys of hydrological stations were conducted by a qualified professional, in this instance, WaterSmith, from July 30 to August 1, 2018. Details of the site visit are reported in Sections 7.10 and 8.3.

Routine monitoring incorporates inspections of equipment, including stilling wells and loggers (*e.g.*, to identify sedimentation inside the stilling well, debris build up in logger ports). QA/QC of all collected data were completed to identify potential station changes or issues like spurious errors and drifts in the automated data. This process included comparisons with previously collected data.

5 Mine Site Environmental Monitoring

5.1 Contact Water Chemistry

Contact water sampling and analysis was conducted as outlined in Section 3.2 of *EMA* Permit 11678 (Appendix A). Contact water sampling is also outlined as per the 2016 *CEMP* and the 2018 *CEMP* (Appendix A). As per the 2018 *CEMP*, monitoring and changes of contact water sites fall under *Mines Act* Permit M-200 and are described in Section 11.6. Refer to Section 4.3 of this report for a discussion of field sampling equipment and methodology.

This section contains data for the permitted effluent site with a prefix letter "E". Sample site and frequency are summarized in Table 5.1. Sample location is shown in Appendix B. As per 2016 and 2018 *CEMP* (Appendix A), legacy sites such as East and West Main Toe Drains, MESCP (E4) and Central Collection Sump (CCS) (E18) that no longer discharge into Hazeltine or Edney Creek have been removed. E11 and E11a (Springer Pit Supernatant) were sources of contact and discharge water under the 2016 *CEMP* and were sampled accordingly until the *LTWMP* discharge permit was approved in 2017 and dredging of the Springer Pit in January 2018, which made that location inaccessible. Note that E19- Perimeter Embankment Till Borrow Pit (PETBP) was included as a surface contact water sites in the 2016 *CEMP* but is discussed in the discharge system and monitoring section of the annual report (Section 6).

E1a, previously E1, is the water chemistry sampling location for the TSF supernatant. The site, E1, was established in 1997 to monitor changes as it was the primary source of discharge water before the TSF embankment breach. No water was stored or samples collected at the site after August 4, 2014. The TSF was operational once again in November 2016 and samples were collected again. Upon receipt of the 2017 *EMA* Permit 11678 amendment, the site name was changed to E1a to reflect the water chemistry post-TSF embankment failure.

Table 5.1 Sampling events in 2018 at contact water quality sites

Site	Site Identifier (EMS No.)	Frequency	
		Permit Requirement	Actual
E1a [a]	E225309	Monthly/Quarterly [b]	13

[a] Deposition of tailings into TSF is ongoing; TSF supernatant being used as reclaim water as of November 8, 2016. E1 has been replaced by E1a.

[b] Required monthly by the 2016 *CEMP* and quarterly by the 2018 *CEMP*.

Samples were submitted to ALS for analysis of:

- Physical parameters (pH, turbidity, TSS, total dissolved solids, and hardness);
- Anions and nutrients (alkalinity, sulphate, total nitrogen, nitrate, nitrite, ammonia, chloride, fluoride, total phosphorus, dissolved phosphorus, and ortho-phosphorus);
- Organics (dissolved organic carbon); and
- Total and dissolved metals (metals suite as listed in *CEMP* (Appendix A).

Thirteen (13) parameters of interest (POIs) were identified in the *Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek* (Knight Piésold Ltd 2009) based on site geochemistry and historical characteristics, as well as existing and projected waste and water management practices. To monitor changes in the effluent surface water quality, in the subsequent sections, these POIs were reviewed for each water quality site over time:

- **Physical Parameters**: Hardness, TSS;
- **Anions**: Chloride, sulphate;
- **Nutrients**: Nitrate, total phosphorus; and
- **Metals**: Dissolved aluminum, total cadmium, total copper, total molybdenum, total and dissolved iron, total selenium.

Results for POI concentrations for the effluent sites are noted and included in tabular format in Appendix E. Note that results below method detection limit (MDL) are represented as half (0.5x) the MDL in statistical calculations and graphs.

Water quality data, including summary statistics (number, minimum, maximum, mean, standard deviations, and method detection limit) are provided in Appendix E.

5.1.1 Site E1a – Tailings Supernatant (E225309)

Water quality at this location was sampled twelve (12) times in 2018. Graphs and results for a subset of parameters only for the post-breach years, are provided in Appendix E. Notable observations in POI results are compared with data over the last five years (pre-breach: 2012-2014, and post-breach: 2016-2018):

Hardness: A general increase in concentration occurred after tailings deposition started post-breach in 2016. However, hardness concentrations are continuing to trend downward to pre-breach levels. The 2018 annual mean was 472 mg/L (lower than 2017 at a mean of 506 mg/L), and overall post-breach mean of 495 mg/L. The pre-breach mean was 438 mg/L. The maximum hardness in 2018 was 551 mg/L.

TSS: Concentrations have remained stable post and pre-breach. The 2018 annual mean was 10.2 mg/L, and the overall post-breach mean is 14.0 mg/L. The maximum TSS post-breach is similar to pre-breach with concentrations of 50.1 mg/L and 54.9 mg/L respectively.

Chloride: Concentrations initially decreased in 2016, but have been increasing to and surpassing pre-breach levels over the past 2 years. The 2018 annual mean was 26.0 mg/L, and overall post-breach mean of 23.0 mg/L. The pre-breach mean was 24.3 mg/L. The maximum chloride post-breach was higher in 2018 with a concentration of 34.2 mg/L than 2017 and pre-breach with concentrations of 25.1 mg/L and 28.0 mg/L respectively.

Sulphate: Concentrations have remained stable post and pre-breach. The 2018 annual mean was 579 mg/L, and overall post-breach mean of 594 mg/L. The pre-breach mean was 542 mg/L. The maximum sulphate post-breach is above pre-breach levels with a concentration of 684 mg/L and 596 mg/L respectively.

Nitrate: Concentrations have increased post-breach but were starting to decrease to pre-breach levels in 2018. The maximum nitrate post-breach was 12.8 mg/L in 2017 and has steadily decreased in 2018 to its lowest concentration of 6.05 mg/L (pre-breach minimum was 4.93 mg/L). The 2018 annual mean was 7.9 mg/L (lower than the 2017 mean of 10.5 mg/L) and the pre-breach mean was 6.4 mg/L.

Total phosphorus: Concentrations have remained stable post and pre-breach. The 2018 annual mean was 0.021 mg/L, with an overall post-breach mean of 0.022 mg/L. The pre-breach mean was 0.015 mg/L. The maximum total phosphorus post-breach is similar to pre-breach with concentrations of 0.07 mg/L and 0.06 mg/L respectively.

Dissolved aluminum: Concentrations have remained stable post and pre-breach (note that there are no data from February 2013 to 2014). The 2018 annual mean was 0.0242 mg/L (with removal of an outlier from March), and overall post-breach mean of 0.0239 mg/L. The pre-breach mean was 0.0215 mg/L. The maximum dissolved aluminum post-breach is similar to pre-breach with concentrations of 0.0505 mg/L and 0.0521 mg/L respectively.

Total cadmium: Concentrations have remained stable post and pre-breach as the majority of results were below detection limit. Only two (2) times were results above detection limit; once in 2016 and 2017. In 2018, all results were below detection limit.

Total copper: Concentrations have increased post-breach but appear to be stabilizing. The 2017 and 2018 annual means were stable at 0.019 mg/L, with an overall post-breach mean of 0.02 mg/L. The pre-breach mean was 0.013 mg/L. The maximum total copper post-breach of 0.083 mg/L is approximately double the pre-breach maximum of 0.041 mg/L.

Total molybdenum: Concentrations have increased post-breach and are continuing in an upward trend. The 2018 annual mean was 0.226 mg/L compared to the 2017 annual mean of 0.186 mg/L and the overall post-breach mean of 0.204 mg/L. The pre-breach mean was 0.184 mg/L. The maximum total molybdenum post-breach of 0.263 mg/L is similar to the pre-breach with maximum of 0.213 mg/L.

Total iron: Concentrations have remained stable post and pre-breach, but total iron is starting to trend downwards. The 2018 annual mean of 0.184 mg/L is lower than the 2017 annual mean of 0.307 mg/L and is also lower than the overall post-breach mean of 0.262 mg/L and the pre-breach mean was 0.272 mg/L. The maximum total iron in 2018 was 0.555 mg/L which is also lower than the post-breach and pre-breach maximums of 0.814 mg/L and 1.47 mg/L respectively.

Dissolved iron: Concentrations have remained below detection limits in pre- and post-breach results, except for one instance in March 2018, with a result of 0.086 mg/L.

Total selenium: Concentrations have remained stable post and pre-breach, but total selenium is starting to trend upwards. The 2018 annual mean was 0.0407 mg/L, with an overall post-breach mean of 0.0378 mg/L. The pre-breach mean was 0.0260 mg/L. The maximum total selenium post-breach of 0.0434 mg/L is higher than the pre-breach maximum of 0.0346 mg/L.

Only three parameters have shown a continuous increasing trend in concentration after post-breach deposition of tailings commenced. Total selenium, total molybdenum, and chloride have shown a general increasing trend, with total copper almost doubling in concentrations in post-breach era but remaining stable. Monthly monitoring was scheduled for E1a under the 2016 *CEMP*. Under the 2018 *CEMP*, the frequency has moved to quarterly, and tailings water is discharged through the WTP via the PETBP.

5.2 Groundwater Monitoring

MPMC contracted Golder as the QP to present and interpret the data from the 2018 groundwater monitoring program. A summary of conclusions and recommendations from Golder's report (Appendix F) is as follows;

Based on the results of this monitoring program, the following conclusions are provided:

- In 2016 and 2017, groundwater levels at GW15-1(a,b), GW15-2(a,b) and GW12-2(a,b) (located on the west side of the mine site) displayed similar trends to surface water elevations within Springer Pit, and appear to be influenced from the filling and emptying of the pit. In 2018, additional dewatering of Springer Pit occurred; although similar trends were noted at GW15-1(a,b), GW15-2(a,b) and GW12-2(a,b), the strongest correlation was identified at GW15-1a, the closest monitoring well to Springer Pit. When these groundwater elevations (particularly those at GW12-2(a,b) and GW15-2(a,b) are greater than the surface water elevation within the pit, it is inferred that a groundwater divide is present between Springer Pit and Bootjack lake (in the area of these monitoring wells). This groundwater divide results in groundwater flowing from these monitoring wells towards to east, to Springer Pit, and towards the west to Bootjack Lake.
- Based on the 2018 groundwater elevations and the water level elevations in Springer Pit, it can be inferred that groundwater leakage from Springer Pit to Bootjack Lake did not occur.
- Significant changes to groundwater quality have not been identified in 2018. Slightly increasing POI concentration trends at the following locations could be indicative of the effects of seepage from some mine facilities:

    - Hardness at GW12-1b, GW15-2b, GW16-1b, GW16-2b, GW11-2a, and GW96-4b.
    - Sulphate at GW12-1b, GW15-2b, GW16-1b, 95R5, GW05-1, GW96-4b, GW16-2b and GW96-3a.
    - Nitrate at GW16-6b, GW16-2b, GW12-1b, GW11-1a, and GW12-4b.
    - Arsenic at GW12-3b, 95R-5, and GW96-3a.

  - Cadmium at GW12-2b.
  - Molybdenum at GW96-7, GW12-4a, GW96-1a, and GW96-3a.
  - Copper at GW12-5b, GW16-8, and GW00-1b.
  - Selenium at GW12-3a and GW05-1.

- Due to the limited data set associated with the monitoring wells around Hazeltine Channel, no discernable trends in the groundwater quality were noted.
- It can be inferred that the change in groundwater sampling technique in mid-2018 has not adversely impacted the interpretation of the analytical results.

Based on the results of the 2018 annual groundwater monitoring report, and as previously noted in Golder's 16 August 2017 technical memorandum summarizing the results of previous hydrogeological assessments conducted in association with Springer and Cariboo Pits (Golder, 2017b), the following recommendations are provided.

- Continue the groundwater level and quality monitoring program at the mine site. This includes measuring the depth to groundwater at the various on-site monitoring wells as per the requirement of the CEMP (preferably on the same day).
- No water levels were measured at GW14-1 and GW05-1 due to the use of the well as a pumping well. If possible, a depth to groundwater, during both pumping and non-pumping conditions, should be measured a minimum of once per year, and specifically, during the one day when the depth to water is measured at all other wells on one given day.
- The groundwater model previously developed for the area between Springer and Cariboo Pits and Bootjack Lake (Golder, 2016a) should be recalibrated using current groundwater and surface water elevations prior to mine closure.

5.3 Climate

EMA Permit 11678 Section 3.6 (Appendix A) requires the collection of detailed meteorology data. The objective of this data collection program is to provide site-specific precipitation, temperature, and evaporation data for use in water balance calculations and hydrological predictions. Mount Polley Mine maintains two (2) automated HOBO weather stations. These stations monitor temperature, rainfall, solar radiation, relative humidity, wind direction, wind speed, and wind gust speed. Weather Station #1 is located approximately one (1) km southeast of Polley Mountain and was installed in September 2012. Weather Station #2 is located northeast of the TSF (between the Rock Quarry and Biosolids Storage Facility) and was installed in November 2012. Due to equipment and battery issues, only partial data were retrievable from Station #2 in February. A summary of the monthly site precipitation, evaporation, and temperature data collected in 2018 is provided in Table 5.2.

Evaporation is calculated by using the Penman-Monteith equation using the WaSIM software developed by Cranfield University. Snowfall measurements are based on monthly snowpack testing done at multiple locations across the site. These measurements are taken at the end of every month, as well as between melting and snowfall events, if forecasted. The snow course method was planned to align with the Snow Survey Sampling Guide (ENV, 1981) in December 2018, however it was delayed to 2019 due to lack of snow.

Table 5.2 Mount Polley 2018 monthly precipitation, evaporation, and temperature data

Month	Monthly Precipitation as Rain (mm)	Monthly Snowpack (mm Snow Water Equivalent)	Evaporation (mm)	Average Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	0.0	92	8	-4.1	6.8	-23.8
February	0.0	225	9	-10.0	1.8	-21.0
March	6.8	266	36	-2.2	13.2	-17.1
April	11.6	0	77	3.2	22.7	-12.3
May	10.3	0	148	13.0	27.4	1.6
June	45.1	0	140	12.8	32.7	1.1
July	22.1	0	178	17.0	32.8	4.2
August	28.1	0	119	15.5	33.0	4.7
September	67.7	0	57	7.4	20.8	-4.8
October	24.4	0	31	4.1	17.1	-7.0
November	74.9	41	8	-0.7	7.3	-9.9
December	0.0	89	25	-4.0	6.3	-12.6

5.3.1 Wind Monitoring

During an audit by WaterSmith in January 2019, it was found that the wind sensor was directed incorrectly at Weather Station #1. The wind sensor was rotated 180° and data have been adjusted accordingly. Wind data for 2018 shows high speed winds are typically observed from the southeast, compared to previous years' that observed a more northwesterly direction (Figure 5.1). While Weather Station #2's data are comparable with past data, Weather Station #1 only depicts data from 2018 as it is unknown for how long the wind sensor was incorrectly directed.

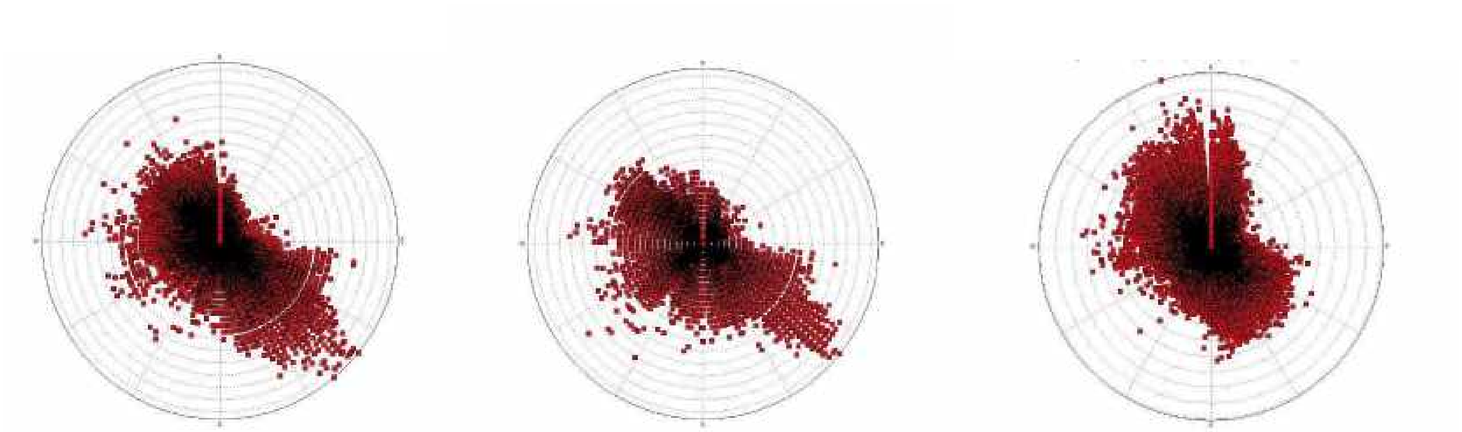

Figure 5.1 Wind data at the Mine site for 2018 (left), and at Weather Station #1 for 2018 (center) and at Weather Station #2 for 2016-2018 (right).

5.3.2 Temperature

In 2018, the lowest monthly mean temperature was -10.0 °C recorded in February, and the highest monthly mean temperature was 17.0 °C recorded in July. Temperatures were colder than average from January to March, but were warmer than average for the rest of the year when compared to site data collected since 1995. Figure 5.2 presents a comparison of 2018 maximum, mean, and minimum monthly temperatures with average monthly temperature data (based on data collected at Mount Polley since 1995). This data are shown in tabular form in Table 5.2.

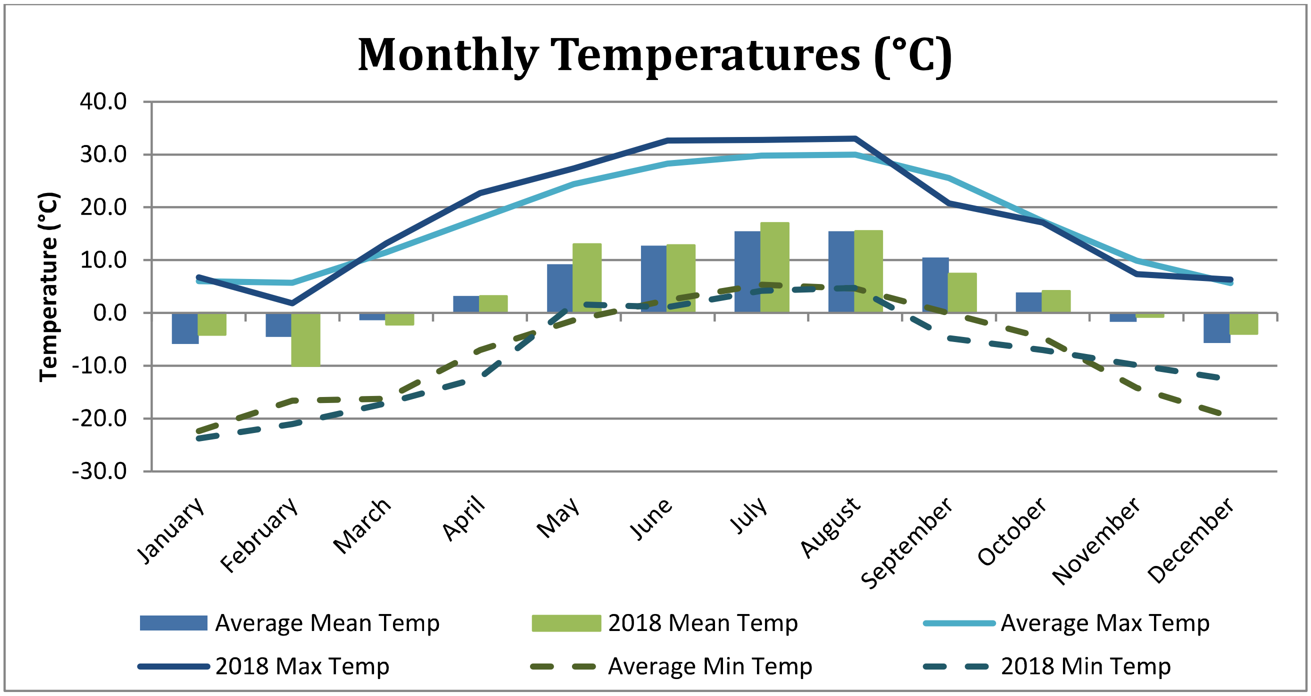

Figure 5.2 Maximum, mean and minimum monthly temperature data for Mount Polley (2018 versus average)

5.3.3 Precipitation

In 2018, 751 millimetres (mm) of precipitation were recorded: 291 mm as rain and 460 mm as snow water equivalent (SWE). This is above the average annual precipitation of 635 mm, with rainfall below its respective annual average but with snowfall above its respective annual average. The 2018 snowpack peaked in March at 266 mm SWE, above the annual average of 174 mm SWE. Total rainfall was lower compared to monthly averages for all months, except in September (68 mm) and November (75 mm). The driest non-freezing month was July, with 22 mm of rain recorded. Precipitation data by month are presented in Table 5.2, Figure 5.3, and Figure 5.4. All precipitation averages are calculated based on data collected at the Mount Polley Mine site since 1995.

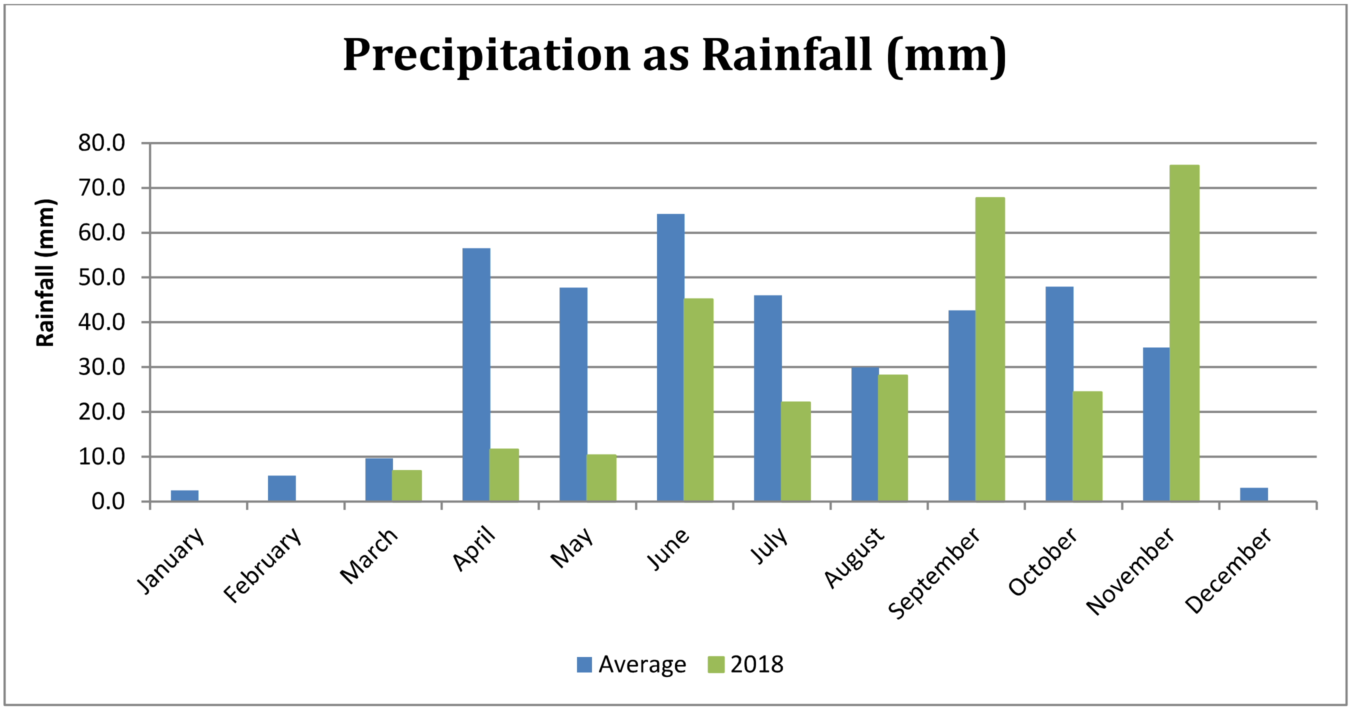

Figure 5.3 Monthly rainfall at Mount Polley (2018 versus average)

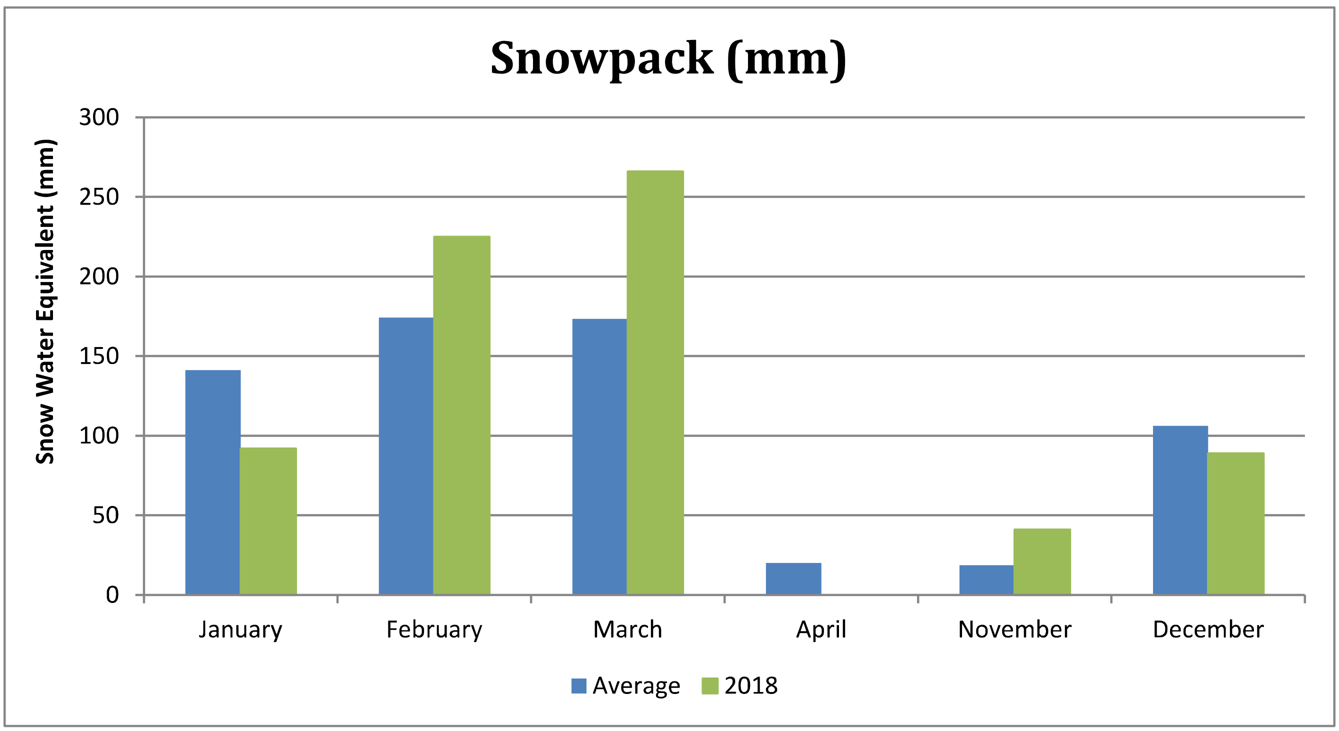

Figure 5.4 Monthly snowpack at Mount Polley (2018 versus average)

5.3.4 Evaporation

Total open water evaporation in 2018 was calculated to be 836 mm. July experienced the greatest amount of evaporation at 178 mm. Monthly evaporation data are presented in Table 5.2. Figure 5.5 presents monthly comparisons of precipitation and evaporation for 2018.

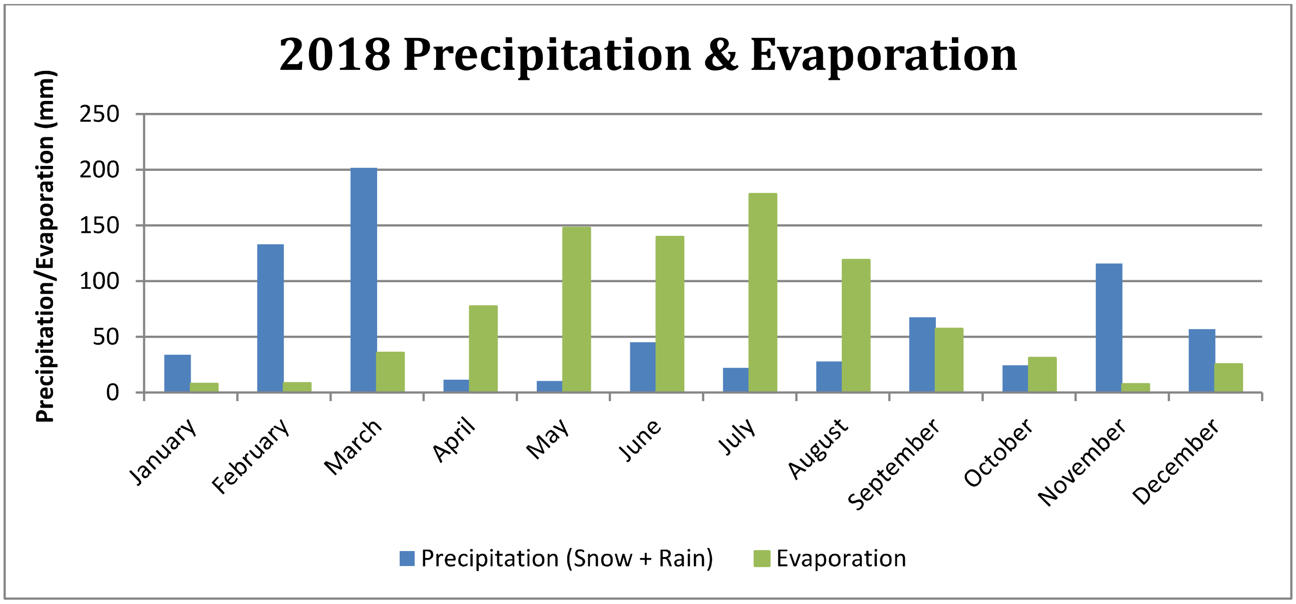

Figure 5.5 Mount Polley 2018 monthly precipitation and evaporation

6 Discharge System and Monitoring

The WTP is a Veolia ACTIFLO® system, which was commissioned in October 2015. Discharge began on December 1, 2015, and continued throughout 2018. The total water discharged in 2018 was 5,174,175 m^3. The *2018 ADP* (MPMC, 2018b; Appendix H) was prepared and submitted to ENV on July 30, 2018 and was approved on September 6, 2018.

6.1 Discharge System

Based on site water management objectives, site contact water is either pumped directly to the TSF or reports to the gravity-driven sections of the West Ditch or Long Ditch, which both ultimately flow to the CCS. Water in the CCS is currently allowed to flow to the PETBP where it is pumped to the WTP. Pumping infrastructure also exists at the CCS such that it can be directed to the TSF. Water from the TSF is primarily pumped to the mill via the Booster Station to meet process requirements, but can also be diverted to the CCS from which it can flow to the WTP via the PETBP. When discharging in 2018, effluent was conveyed from the WTP into a direct pipeline and fed directly into Quesnel Lake at depth through a pair of diffusers.

6.1.1 Treatment Works and Source Control Optimization

MPMC was required to assess and optimise the existing treatment process and works on a regular basis under Section 2.9 of *EMA* Permit 11678. Two copper optimization updates reports were submitted in 2018.

The first deliverable completed bench-scale testing of various dosing rates of the same current polyaluminum chloride (PAC) coagulant and adding a trimercaptotriazine (TMT) ligand in addition to the PAC for copper removal at the WTP. This would especially be used during freshet (Golder, 2018a).

The second deliverable outlined the implementation of the TMT dosing onsite to optimize the existing WTP for periodic treatment of elevated copper concentrations during freshet with field trials planned for spring 2019. ENV has requested that the optimization target a copper effluent concentration of 0.012 mg/L; while it was possible to achieve this concentration during bench-scale testing; it is not presently known if the lower limit is feasible at full-scale under field conditions (Golder, 2018b).

6.1.2 WTP Operations

During treatment, the feed water of the WTP undergoes suspended solids removal using Veolia ACTIFLO® water treatment technology prior to discharge. The WTP doses the raw water with coagulant to a tank where a polymer is injected to create floc particles. Microsand is added to ballast the flocculants, which move on to another tank that allows them to swell and mature. The water flows to the next stage, which uses lamella to clarify the water and promote fast settling of the microsand ballasted sludge. The clarified water is discharged and the sludge is separated from the microsand, which is reused. An on-line turbidity meter measures the turbidity every ten seconds and calculates the TSS using a calibrated factor based on a site- specific correlation between turbidity and TSS. If an on-line TSS measurement is above 11 mg/L for 10 minutes, or over 12 mg/L instantaneously, an alarm sounds to alert the operator and the WTP automatically goes into recirculation mode and ceases discharge.

The WTP started discharging to Quesnel Lake via the direct pipeline on January 8, 2018. There were periodic times when the WTP was put into recirculation mode due to various issues described in Table 6.1. The annual average discharge rate was 16,789 m^3/day and daily maximum discharge rates ranged from 0 m^3/day to 21,884 m^3/day. According to the *EMA* Permit 11678, the authorized annual average discharge rate is 29,000 m^3/day and a daily maximum discharge rate of 52,000 m^3/day. Daily maximum rates are provided in Appendix G.

Table 6.1 Reasons for discharge stoppages in 2018.

Date	Discharge Action	Reason
8-Jan-18	Started	Authorized to discharge via direct pipeline
12-Jan-18	Ceased	QUL-58 surface sample exceeded permit limit
29-Jan-18	Restarted	Subsequent sampling showed no permit limit exceedances
5-Mar-18	Ceased	HAD-03 sample exceeded permit limit
7-Mar-18	Restarted	Subsequent sampling showed no permit limit exceedances
10-May-18	Ceased	HAD-03 sample exceeded permit limit
30-May-18	Restarted	Subsequent sampling showed no permit limit exceedances
31-Jul-18	Ceased	Unforeseen maintenance issues
2-Aug-18	Restarted	Issues fixed
22-Aug-18	Ceased	HAD-03 sample exceeded permit limit
24-Aug-18	Restarted	Lab error
14-Nov-18	Ceased	No operator available on night shift
15-Nov-18	Restarted	Operator on day shift
15-Nov-18	Ceased	No operator available on night shift
16-Nov-18	Restarted	Operator on day shift
30-Dec-18	Ceased	Precaution for preliminary HAD-03 result

6.1.3 Outfall and Pipeline Commissioning and Inspection

As required by in Section 3.5 of *EMA* Permit 11678 (Appendix A), routine visual inspection of the outfall into Quesnel Lake, along with the pipeline, must be conducted. MPMC conducts routine inspections and maintains records of these routine inspections.

A comprehensive inspection and testing program of the outfall must be conducted (which includes an annual leak and pressure testing of the pipeline), and an underwater inspection of the diffuser every 2 years. As the pipeline is gravity fed and buried, the leak and pressure testing is not possible. The inspection at the Quesnel Lake diffusers has been conducted annually from 2015 to 2018 by a QP. A comprehensive inspection of the diffusers was conducted on September 5, 2018 and on the pipeline on September 24, 2018. Recommended frequency of the diffuser inspection have changed to every 5 years (starting with 2023), but pipeline inspections by a QP remain annual. The final report was submitted to ENV.

Recommendations from the inspection are panned to be completed in the summer of 2019. The recommendations include:

- Replace the improper-sized flange bolt with a bolt that matches the others
- Cut-out and replace the damaged section of pipeline near the WTP
- Cover the exposed section of pipeline adjacent to the WTP and place barricades or delineators to clearly mark the pipeline and to reduce the risk of damage from vehicle/equipment contact
- Metal plates that are missing from markers in the lower half of the pipeline should be replaced
- Standing water along the pipeline right-of-way should be drained. Once completed grading should be completed to prevent re-accumulation of standing water
- Add stockpiled topsoil or wood debris to areas that are slow to re-vegetate to help with erosion control
- The temporary steel splitter between the HDPE pipe and the existing pipelines near Quesnel Lake must be replaced with a permanent HDPE wye piece

6.2 Discharge Monitoring

This section provides an assessment of the compliance with the amended *EMA* Permit 11678 limits with respect to the data collected at the WTP discharge end-of-pipe site (HAD-03) and at the edge of the initial dilution zone (IDZ) site (QUL-58) in Quesnel Lake. These data were collected in accordance with the approved 2016 and 2018 *CEMP* (Appendix A) and the ADP (Appendix H). This compliance is primarily based on the permit conditions stipulated in the *EMA* Permit 11678 dated April 7, 2017 and October 2, 2018. This section addresses the *EMA* Permit 11678 Section 3.9 requirements:

- *(e) a summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment;*
- *(k) a comparison of monitoring data with water quality guidelines, predictions, and targets.*

This discharge triggered the *MDMER* and reporting to Environment and Climate Change Canada continued in 2018 as outlined in the *MDMER*. All requirements were met with the exception of the monthly acute toxicity testing in May due to the shutdown of the discharge. Table 6.2 outlines the number of sampling events at each site in 2018 (a map of these locations is provided in Appendix B).

Table 6.2 Sampling events in 2018 at discharge monitoring sites

Site Name	Site Identifier (EMS No.)	Full Sample Suite Frequency 2016 *CEMP*	Full Sample Suite Frequency 2018 *CEMP*	Actual Sampling Events
E19	E305050	Weekly [a]	Weekly [a]	63
HAD-03	E304230	Weekly [a]	Weekly [a]	59
QUL-57	E304874	Weekly/Monthly [b]	4 times per year	1
QUL-58	E304876	Weekly/Monthly [c]	4 times per year	20
QUL-59	E304875	Weekly/Monthly [b]	4 times per year	1
QUL-2a	E303020	Monthly	4 times per year	6
QUL-18	E303019	Monthly	4 times per year	7
QUL-120a	E303022	Seasonally	Bi-annually	3
QUR-11	E306454	Monthly	Removed [d]	10

[a] When discharging.

[b] Limnological profiles occur weekly for 5 weeks during spring and fall turnover; monthly all other times of the year.

[c] Samples and limnological profiles occur weekly for 5 weeks during spring and fall turnover; monthly all other times of the year.

[d] Effective as of on November 9, 2018 with the acceptance of the 2018 *CEMP*.

6.2.1 Permit Compliance

The *EMA* Permit 11678 requires the following regulatory compliance be met:

1. Effluent chemistry data from end-of-pipe at HAD-03 (WTP outflow) must be equivalent to or less than specified values in Section 1.2.3 of the Permit (Appendix A). In addition, the trigger and response plan required under Section 2.7 (5) must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake specified in Section 1.2.3 of the Permit.
2. Effluent must meet the acute toxicity requirement of less than 50% mortality in 100% effluent in 96-hour rainbow trout (*Oncorhynchus mykiss*) and *48-hour Daphnia magna* toxicity tests (*EMA* Permit 11678 Section 3.3 and 3.10). These results are presented in Section 6.3.

6.2.2 Influent Chemistry – E19

In accordance with the 2016 and 2018 *CEMP*, E19 (WTP feed) water samples were collected weekly and concurrently with HAD-03 samples during effluent discharge. E19 represents the water entering (influent) into the WTP; the influent is pumped from the PETBP which collects the contact water from the Mount Polley Mine site. Sixty-three (63) samples were collected from E19 in 2018. The influent results are compared with the effluent results to gauge treatment efficiency. The WTP monitors the influent flow rate, turbidity and temperature.

6.2.3 Effluent Chemistry – HAD-03

To meet the requirements of the *EMA* Permit 11678 and *MDMER* requirements, water chemistry samples were collected weekly at the end-of-pipe site at the WTP outlet (site HAD-03) when discharging. Note that there were periodic times when there was no discharge; see Table 6.1 for details. This requirement was met by the collection of fifty-nine (59) samples at HAD-03 in 2018. All parameters were met or were below the concentrations limits in Section 1.2.3 of the Permit except for a few instances (Section 6.2.4).

The permit limit for total copper according to Section 1.2.3 of the *EMA* Permit 11678 is 0.033 mg/L. There were two (2) sampling events on May 8 and May 10, 2018 where total copper exceeded the permit limits (Section 6.2.4.2). The maximum result for total copper at HAD-03 in 2018 was 0.282 mg/L on May 10; the annual average was 0.029 mg/L. Results for the influent and effluent are shown below in Figure 6.1.

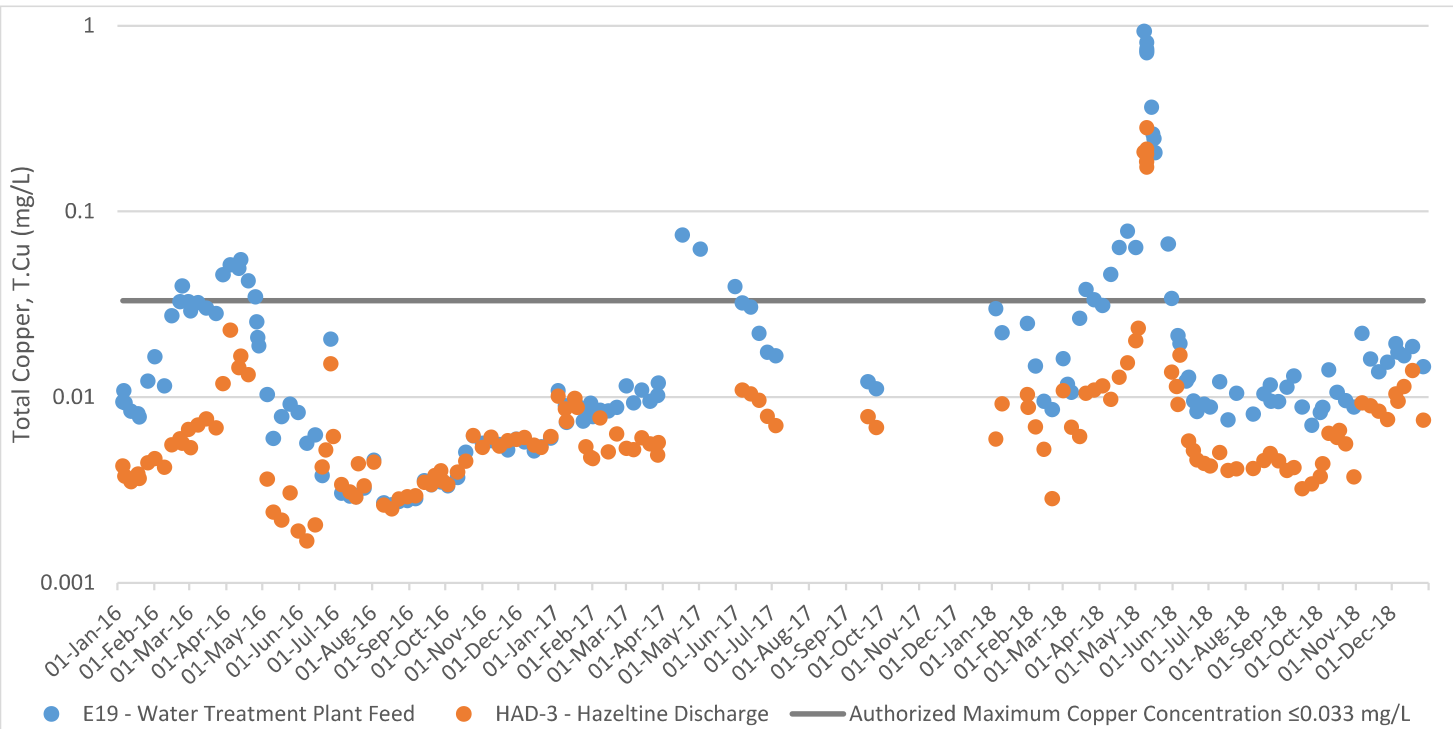

Figure 6.1 Total copper concentrations in influent (E19) and effluent (HAD-03) in from 2016-2018.

There were no exceedances of TSS in 2018. The maximum total TSS limit must be equivalent to or less than 30 mg/L with a monthly average equivalent to or less than 15 mg/L. The maximum result for TSS at HAD-03 in 2018 was 18.5 mg/L in December; the annual average was 6.8 mg/L. The maximum 30 day average TSS was 10.5 mg/L in December 2018. Results for influent and effluent are shown in Figure 6.2.

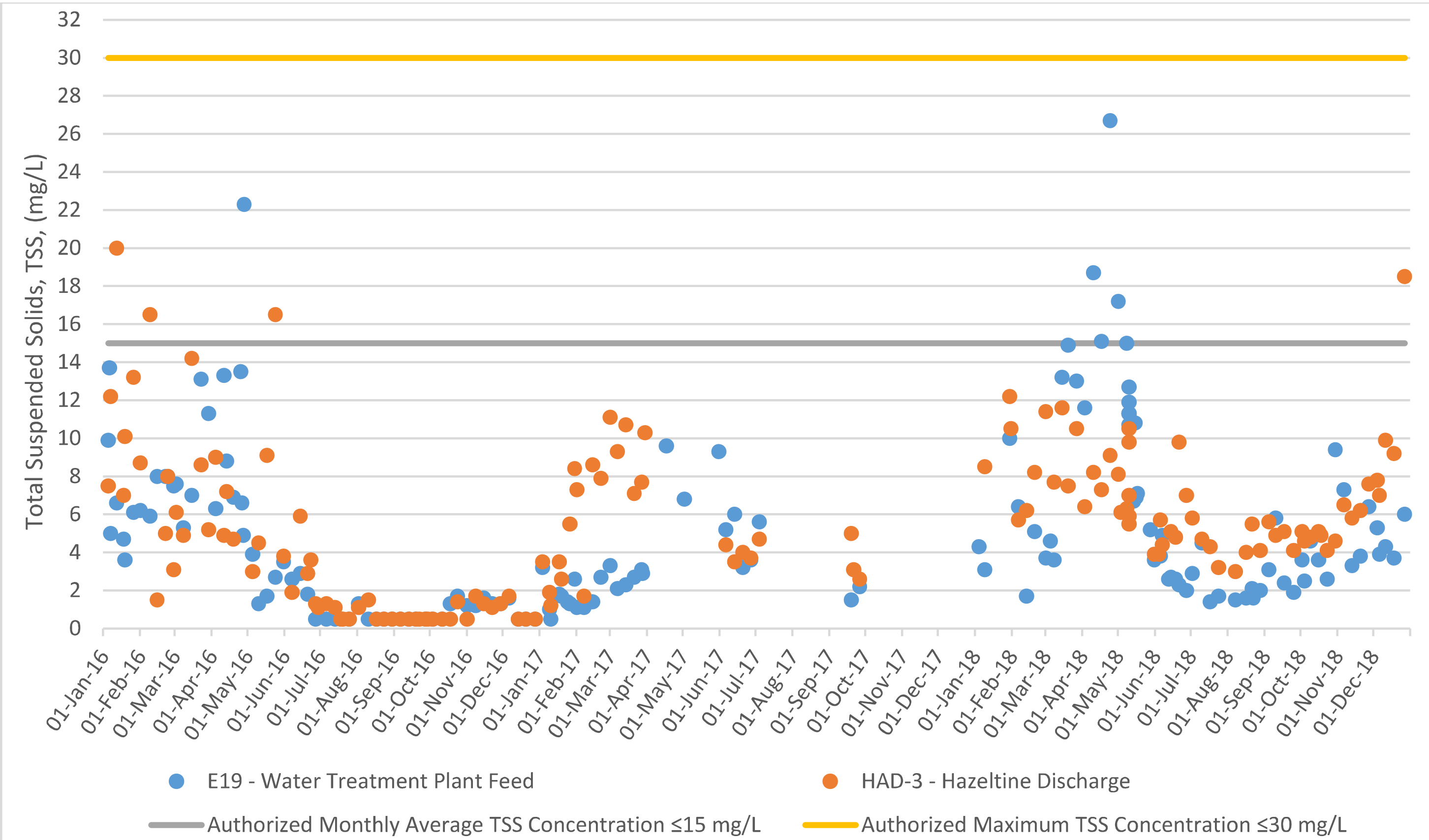

Figure 6.2 Total suspended solids concentrations in influent (E19) and effluent (HAD-03) in 2016-2018.

6.2.4 HAD-03 Permit Limit Exceedance Events

In 2018, there were five instances where ALS results from HAD-03 samples were above the permit limits. Each time, MPMC notified the required parties and an investigation was undertaken. Below is a list of the exceedances in 2018:

- Dissolved aluminum on February 20, 2018*
- Dissolved aluminum on April 17, 2018*
- Total copper and dissolved cadmium on May 10, 2018
- Dissolved aluminum on August 16, 2018*
- Total phosphorus on December 27, 2018*

* Not considered to be true exceedances; see Sections 6.2.4.1 and 6.2.4.3 for further explanations.

6.2.4.1 Dissolved Aluminum

Dissolved aluminum from the February 20, 2018 sampling event at HAD-03 resulted in a concentration of 1.09 mg/L which was above the permit limit of 0.75 mg/L. When the result was noted on March 5, 2018 (final results may take up to two weeks), MPMC requested emergency turnaround for the subsequent samples, a recheck of the result and the WTP was put into recirculation mode. Initially this was believed to be a sampling error as other locations sampled the same day also had relatively elevated dissolved aluminum. Subsequent sample of HAD-03 from March 1 and a sample from the recirculation of the WTP on March 5, 2018 both returned a dissolved aluminum concentrations of 0.139 mg/L and 0.0703 mg/L, respectively. The samples were below the permit limit and the WTP resumed discharge on March 7, 2018. ENV was notified of the exceedance during a telephone meeting on March 12, 2018. MPMC was reminded during the call to submit a notification even if the issue was no an exceedance but rather a sample error.

Dissolved aluminum from the April 17, 2018 sampling event at HAD-03 resulted in a concentration of 0.971 mg/L which was above the permit limit of 0.75 mg/L. When the result was noted on May 4, 2018 (final results may take up to two weeks), MPMC notified all required parties and promptly requested emergency turnaround for the subsequent samples, and a recheck. The result from the April 24 sampling event was 0.0944 mg/L and all additional samples were below the permit limit of 0.75 mg/L, therefore the WTP was not shut down. The investigation outcome signaled possible sporadic problems with the WTP system or the mixing reagents and testing and sampling of various dosages were scrutinized. A follow up report was submitted to ENV on June 5, 2018.

Dissolved aluminum from the August 16, 2018 sampling event at HAD-03 resulted in a concentration of 0.818 mg/L which was above the permit limit of 0.75 mg/L. When the result was noted on August 22, 2018 (final results may take up to two weeks), MPMC notified all required parties and promptly requested emergency turnaround for the subsequent samples, a recheck, and the WTP was put into recirculation mode. ALS notified MPMC that the dissolved metals were not filtered and preserved in the lab, and that re-analysis of dissolved metals would initialized. Re-analysis values after proper filtration and preservation returned a dissolved aluminum concentration of 0.101 mg/L and the WTP resumed discharge on August 24, 2018. As this was a false exceedance, a follow up email was sent on August 29, 2018 detailing the findings.

The dissolved aluminum exceedances did not follow any particular trend (e.g. heavy rain event, different dosing factors), but were rather sporadic in nature. The investigations for the February and April samples initially reported that the exceedances were a result of sampling error or a malfunction of the WTP in the coagulant dosing factor (as the coagulant is polyaluminum chloride reagent). Upon consultation with ALS laboratories for the August sample, it was found that the dissolved metals were not being filtered and preserved in the lab as explicitly requested on the Chain of Custody (COC), therefore resulting in a false dissolved aluminum exceedance. Further inspection revealed that this was the case for the February and April exceedances. MPMC and ALS have taken additional precautions and measures to prevent these false results from occurring.

6.2.4.2 Total Copper and Dissolved Cadmium

Total copper from the May 8, 2018 sampling event at HAD-03 resulted in a concentration of 0.209 mg/L which was above the permit limit of 0.033 mg/L. Subsequent samples (4 were collected) from May 10 revealed an average total copper concentration of 0.212 mg/L, with a maximum concentration of 0.282 mg/L as well as an average dissolved cadmium concentration of 0.000375 mg/L (dissolved cadmium permit limit is 0.00034 mg/L). When the results were received on May 11, 2018 (emergency turnaround had been requested for the above samples due to the dissolved aluminum exceedance from April), MPMC notified all required parties, and the WTP was put into recirculation mode. The investigation into the cause indicated that two (2) seeps from the NEZ waste rock pile were elevated in copper and other metals (but the pH remained relatively neutral). Further investigation into the source of these elevated metals is on-going. The investigation is focused on elemental sulphur pile and the leachate collection recycle system (LCRS) which both lie approximately 140 m above and 1 to 1.5 km west of the NEZ. The sulphur pile may have been undergoing chemical reactions causing leaching in the NEZ or the LCRS may have been leaking. Measures were taken to mitigate the influence of the seeps into the WTP feed by constructing a sump at the base of the seeps, and pumping the water to mill. Until the elevated parameters met the treatment capabilities of the WTP, the source of the discharge was fed from the TSF instead of the CCS to the PETBP.

6.2.4.3 Total Phosphorus

Total phosphorus from December 27, 2018 was initially reported to have a concentration of 13.8 mg/L which was above the permit limit of 0.09 mg/L. The WTP was promptly shut down, required parties notified, and recheck and reanalysis requested. The elevated initial total phosphorus concentration was a result of an error was confirmed by ALS as a sample mix-up and the actual result was below the permit limit at 0.0086 mg/L. MPMC emailed ENV, retracting the total phosphorus exceedance, and the WTP resumed discharging.

6.2.5 Plume Dispersion Model

Tetra Tech Inc. (Tetra Tech) was retained by MPMC to assess the long-term and far-field fate of effluent discharged from the diffusers in Quesnel Lake (see Section 6.1). Tetra Tech applied the existing hydrodynamic model of Quesnel Lake to simulate effluent concentrations throughout the lake as a result of the discharge. After the simulations were completed, MPMC requested advice with respect to the likely position of the effluent plume by month, to support monitoring in the field (Tetra Tech, 2016). In 2017, Tetra Tech was retained to determine the relationship between the volumetric dilution by a dilution test and dilution calculated from observed specific conductivity from limnological profiles in Quesnel Lake. The results improved the confidence of the estimated dilution factor applied to the profiles. Tetra Tech ran the near-field model to discuss the plume width and dilution and concluded that there was only a 3% chance of detecting the plume at the IDZ. In addition, the field models suggest the plume concentrations are generally less than 1% at the IDZ (MPMC, 2018a). In 2018, Tetra Tech was requested to conduct an analysis of the limnological profiles and data from Quesnel Lake and provide conclusions and recommendations in order to better understand the lake circulation, and the interaction of the lake with the effluent discharge. Tetra Tech's review identified some of the specific conductivity spikes observed at shallower depths stemmed from surrounding creek sources. Other observations noted that the effluent's density during certain periods of the year may be greater than originally modeled. This may be contributing to a gradual increase of dilute effluent under the thermocline and is expected to flush out during the spring and fall overturns (Appendix I).

6.2.6 Receiving Environment Chemistry – Quesnel Lake

The receiving environment for the water discharge plan is Quesnel Lake and further downstream Quesnel River. In accordance with the 2016 *CEMP*, (see Table 6.2), monitoring at the edge of the initial dilution zone (IDZ), site QUL-58, in Quesnel Lake occurred monthly, with intensive sampling during overturn periods, when treated effluent was discharging in 2018. In accordance with the 2018 *CEMP*, monitoring changed to four times per year.

In situ limnological profiles, Secchi measurement (see Section 8.6.2) and grab samples were collected for water chemistry at the inferred centerline of the effluent plume (when discharging) at the compliance site QUL-58 (when weather conditions were safe). A reasonable amount of effort was spent looking for the discharge plume by observing any increases in specific conductivity. If the plume was detected, grab samples were taken at surface (QUL-58-S), 5 m above the plume (QUL-58-AP), middle of plume (QUL-58-MP), 5m below the plume (QUL-58-BP), and at bottom (QUL-58-B), with additional profiling at supplemental stations, QUL-57 and QUL-59, located at the edge of the IDZ, 25 m on either side of QUL-58 (plume centerline). If the plume could not be detected, then sampling occurred at the default QUL-58 site at the surface (QUL-58-S), bottom (QUL-58-B), mid-depth (QUL-58-MID) (if no thermocline) or 1 m above (QUL-58-AT) and below (QUL-58-BT) the thermocline (if present).

In 2018, there were twenty (20) sampling events at edge of the IDZ (QUL-58). Five (5) of those events occurred when the treated effluent was not discharging (see Table 6.3). The plume may have been detected during the field investigations along the IDZ on January 10 and 31, 2018 and October 11, 2018 when the WTP was discharging treated effluent.

Table 6.3 Effluent discharge condition during IDZ sampling at QUL-58

Date sampled	Treated effluent condition
4-Jan-18	Not discharging
10-Jan-18	Discharging
18-Jan-18	Not discharging
31-Jan-18	Discharging
3-May-18	Discharging
13-May-18	Not discharging
22-May-18	Not discharging
4-Jun-18	Discharging
13-Jun-18	Discharging
18-Jun-18	Discharging
27-Jun-18	Discharging
2-Jul-18	Discharging
23-Aug-18	Not discharging
4-Sept-18	Discharging
11-Oct-18	Discharging
18-Oct-18	Discharging
24-Oct-18	Discharging
29-Oct-18	Discharging
7-Nov-18	Discharging
18-Dec-18	Discharging

In addition to the field investigation, MPMC retained Tetra Tech to develop near-field models to predict the plume direction and depth using the conductivity from the limnological profiles from Quesnel Lake (Section 6.2.5) The results from the Tetra Tech's memo in Appendix I indicate that the detection of conductivity 'spikes' at shallower depths are from higher conductivity Hazeltine and/or Edney creek water; while at bottom waters in the West Basin, slightly elevated conductivity measurements stem from dilute effluent trapped beneath the thermocline and the sill near Cariboo Island (Appendix I).

6.2.6.1 Permit Limits at the edge of Quesnel Lake IDZ

The amended *EMA* Permit 11678 (April 7, 2017) included compliance limits at the edge of the Quesnel Lake IDZ. All parameters met or were below the concentrations limits in Section 1.2.3 of the Permit with the exception of two instances were copper concentrations were above the permit limit at the surface (Appendix G).

Total copper from the January 10, 2018 sampling event at QUL-58-S resulted in a concentration of 0.00302 mg/L which was above the permit limit of 0.0022 mg/L. When the result was noted on January 12, 2018, MPMC ceased discharging, notified all required parties and additional sampling was done as soon as safely possible. The results from the January 18, 2018 sampling event at QUL-58 were below the permit limits and the WTP resumed discharging on January 29, 2018.

Total copper from the May 13, 2018 sampling event at QUL-58-S was 0.00279 mg/L which was above the *EMA* Permit 11678 limit of 0.0022 mg/L. The WTP was already in recirculation mode due to the exceedances at the discharge (Section 6.2.4.2) however, QUL-58-S was deemed not to be a compliance point due to other significant surface flows from various inputs into Quesnel Lake (MPMC, 2018b; Appendix H). Furthermore, the plume simulation does not expect the plume to rise to the surface (Tetra Tech, 2016). Results from the May 22, 2018 sampling event at QUL-58 were below permit limits and the WTP resumed discharge on May 30, 2018.

Total copper results for the edge of the Quesnel Lake IDZ (site location QUL-58) are shown below (Figure 6.3). The annual total average of total copper at the IDZ in 2018 was 0.0011 mg/L. Reviewing non-surficial sample data, the maximum total copper concentration was 0.0017 mg/L at the bottom at QUL-58 in May when the WTP was discharging; the maximum total copper concentration (when the WTP was not discharging) was 0.0013 mg/L in January at mid depth at QUL-58. Note that the maximum results were similar when the WTP was discharging and not discharging. As there are many inputs into Quesnel Lake, it is hard to pinpoint exactly which sources are contributing to the total copper results but these results indicate that the discharge is not the sole contributing factor.

6.2.6.2 ADP – Trigger Response Plan

The *ADP* was submitted to ENV on July 30, 2018 as required per Section 2.7 of *EMA* Permit 11678 and accepted on September 6, 2018 (Appendix H). The permit was amended on October 2, 2018 to reflect the changes brought forth with the updated *ADP* (Appendix A). The major requirement of the *ADP* was to include a *TRP*, which outlines the steps in the event that the water quality results are within 80% of the permit limits at HAD-03 and/or exceed permit limits at HAD-03 and/or QUL-58.

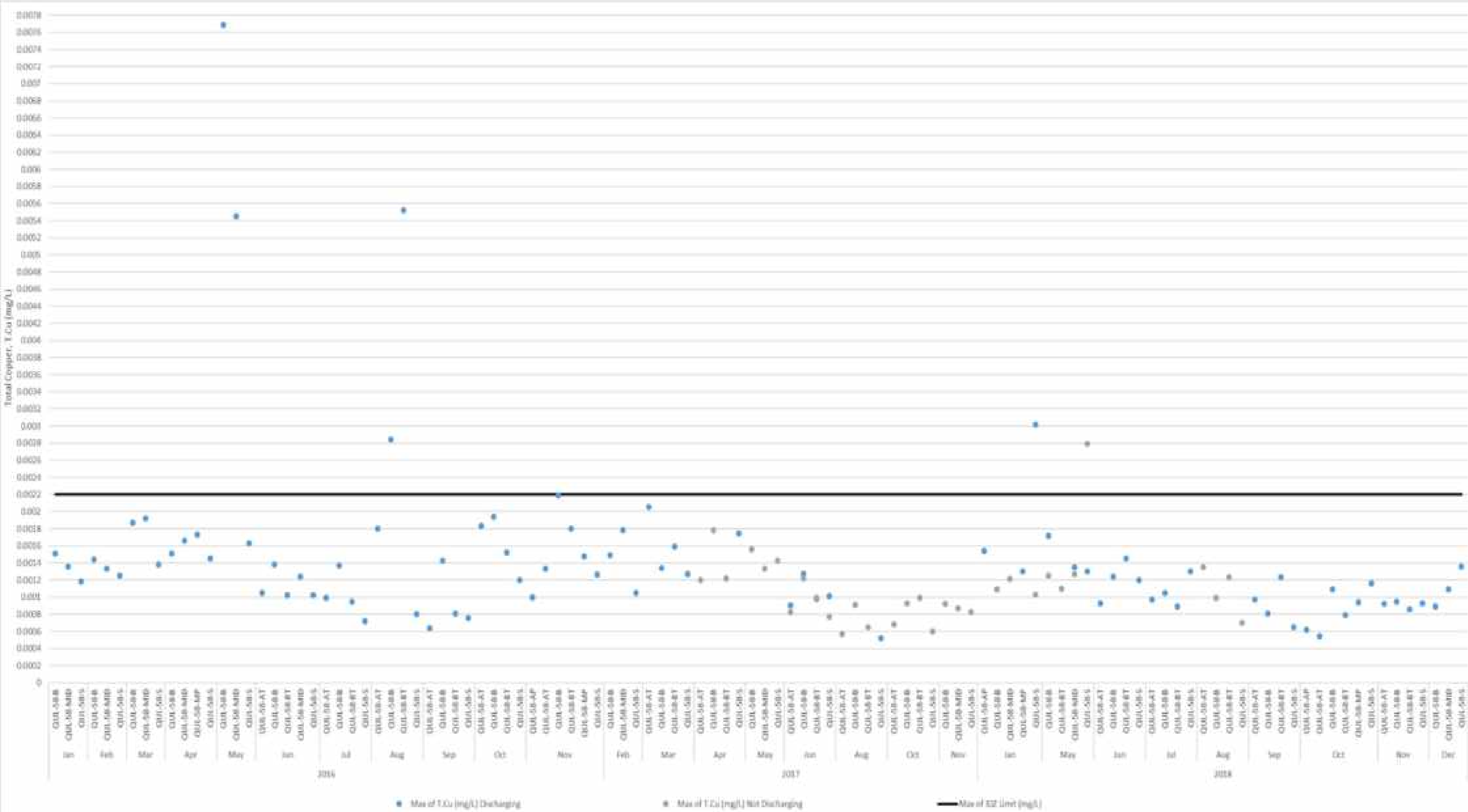

Figure 6.3 Total copper results at the IDZ (QUL-58) from 2016-2018

In addition, the *ADP* contains an analysis of the remaining capacity of Quesnel Lake using the dispersion model and background concentrations (Figure 6.4). MPMC maintains this tool to check if permit limits and water quality guidelines are being met at the IDZ without monitoring on the lake during unsafe conditions (Appendix H).

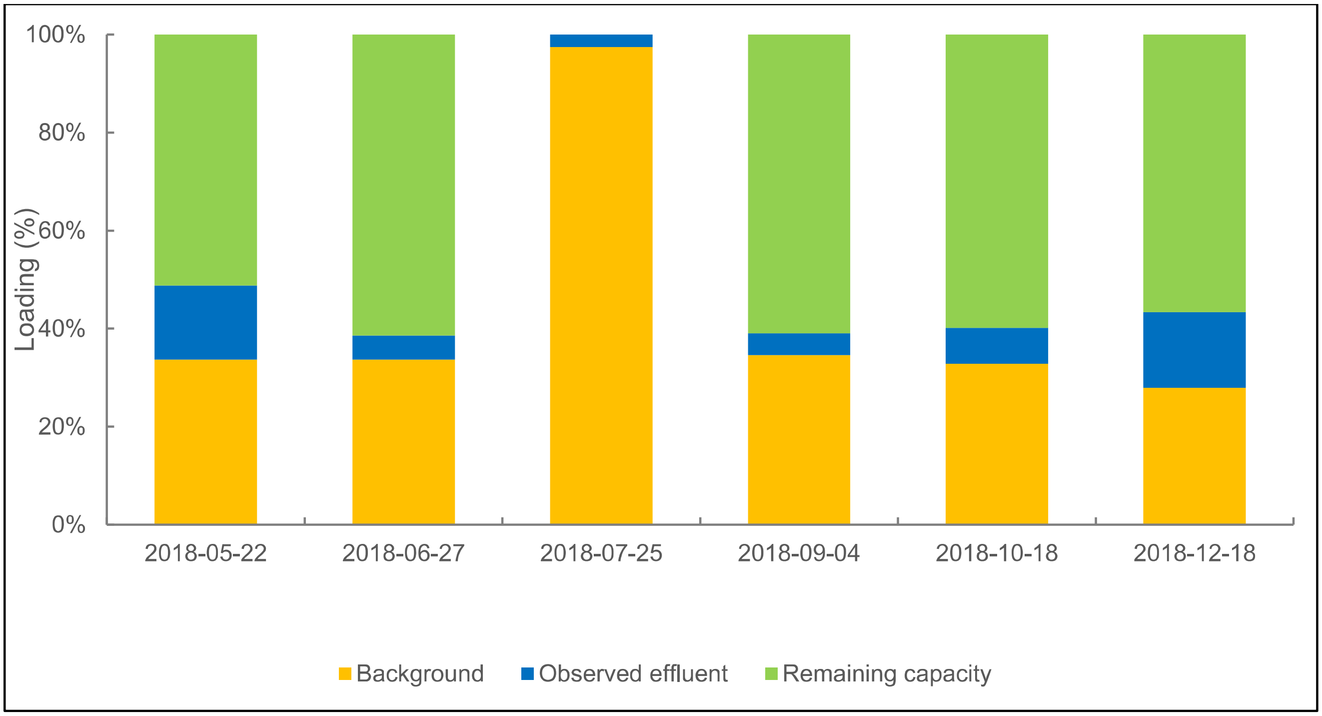

Figure 6.4 Calculated assimilative capacity of total copper on a daily basis in 2018.

Further to the *ADP,* Golder completed two memos: *2018 Verification of Near Field Modelling in Quesnel Lake* and a *Comparison of Water Quality Model Prediction* (Appendix I). These documents provided updates to the previous near field dispersion modelling validation and water quality models at the discharge with 2018 data. The first memo involved calculating the dilution factors in Quesnel Lake during periods of discharge and no discharge from the WTP. The calculated dilution factors ranged from 40 to over 100 when the discharge was active. These results confirm the conservative model predictions and effluent mixing in the lake tends to higher than expected (Appendix I). The second memo compares the 2018 data with predictions described in the *LTWMP TAR* (Golder, 2016b). The comparison indicate the measured concentrations are below model predictions and *EMA* Permit 11678 limits with some exceptions (Appendix I).

6.2.6.3 BC WQG at the edge of Quesnel Lake IDZ

Short-term maximum and long-term average BC WQG for aquatic life concentrations were compared with the water chemistry data from QUL-58. These limits are not considered compliance limits as MPMC is regulated with *EMA* Permit 11678 requirements at the IDZ. Total copper (Figure 6.7) (except in 2016) and other parameters for the BC WQG for aquatic life guidelines were met (with the exception of total phosphorus).

Note that samples were taken monthly at QUL-58, with bi-annual intensive sampling during spring and fall turnover (dependent on weather conditions and safety). As summarized in Table 6.3, spring intensive sampling occurred during June and early July and fall intensive sampling occurred in October and early November (i.e. five (5) samples in thirty (30) days) in 2018, which can compared to the long term average total copper guideline (Figure 6.7). The data in Figure 6.7 are depth integrated average concentrations for simplicity. All other data points are presented for screening purposes only. Note that all concentrations from QUL-58 were below the short-term maximum BC WQG for total copper in 2016 through 2018. All concentration from QUL-58 were below the long-term average BC WQG for total copper except during two (2) sampling events in 2016 during the spring intensive sampling. Figure 6.5 and Figure 6.6 show the data for 2016 and 2017.

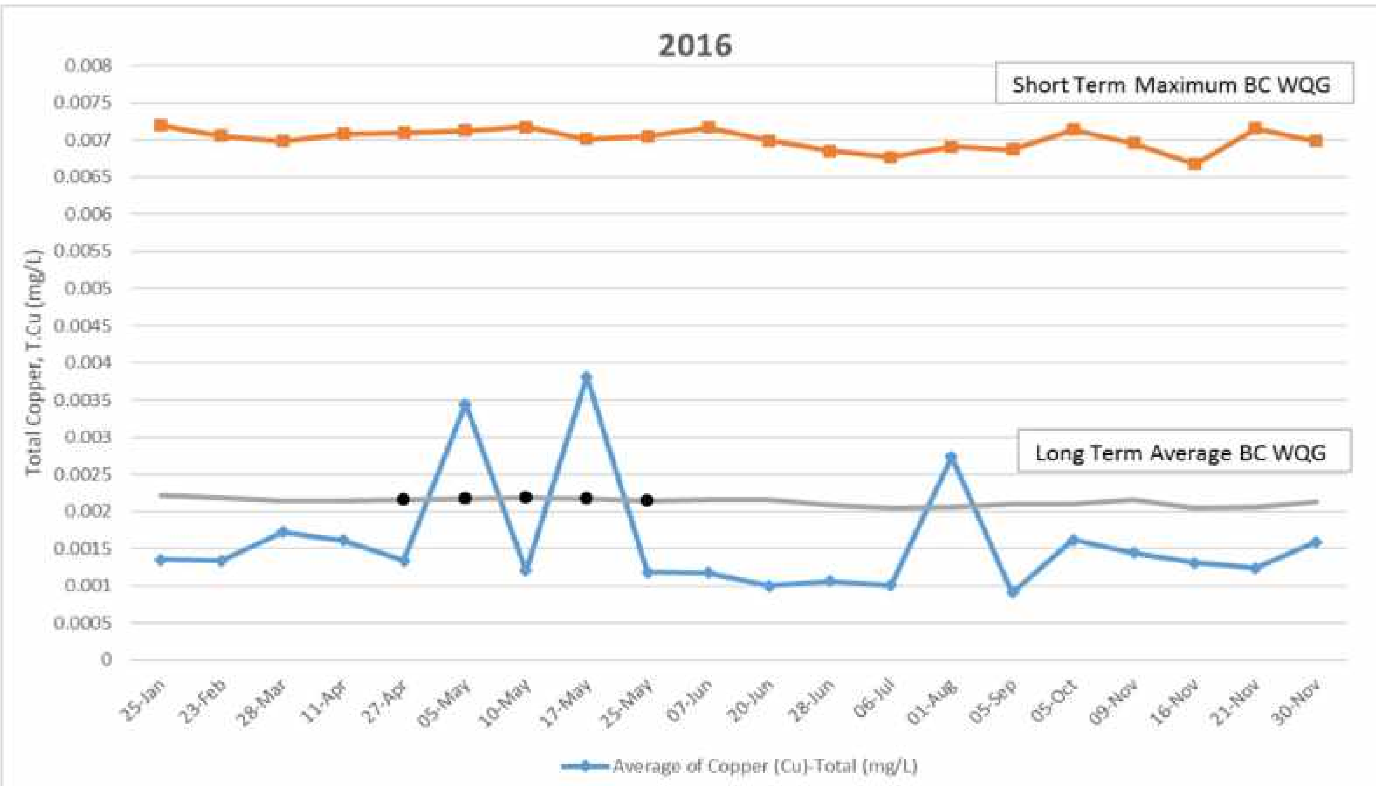

Figure 6.5 Short and long-term BC WQG for aquatic life total copper concentrations at QUL-58 in 2016. The black dots discern applicable long-term average BC WQG for aquatic life (5 samples in 30 days).

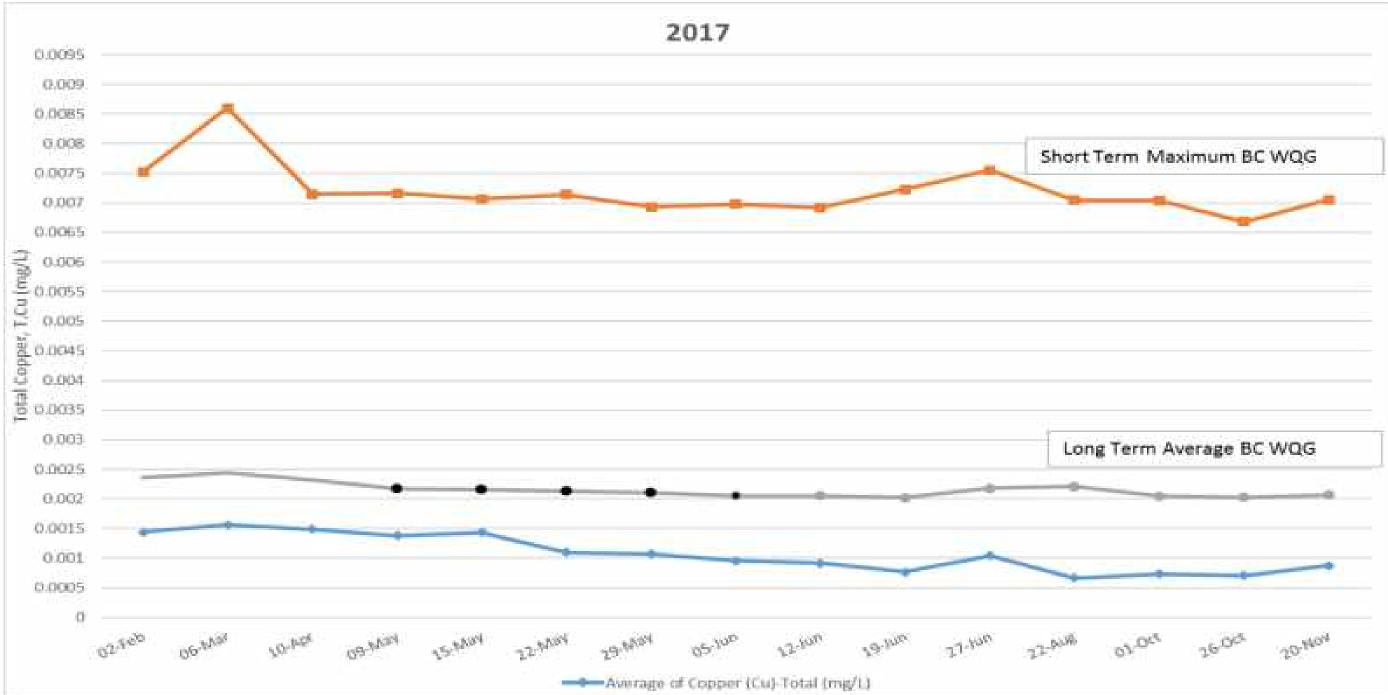

Figure 6.6 Short and long-term BC WQG for aquatic life total copper concentrations at QUL-58 in 2017. The black dots discern applicable long-term average BC WQG for aquatic life (5 samples in 30 days).

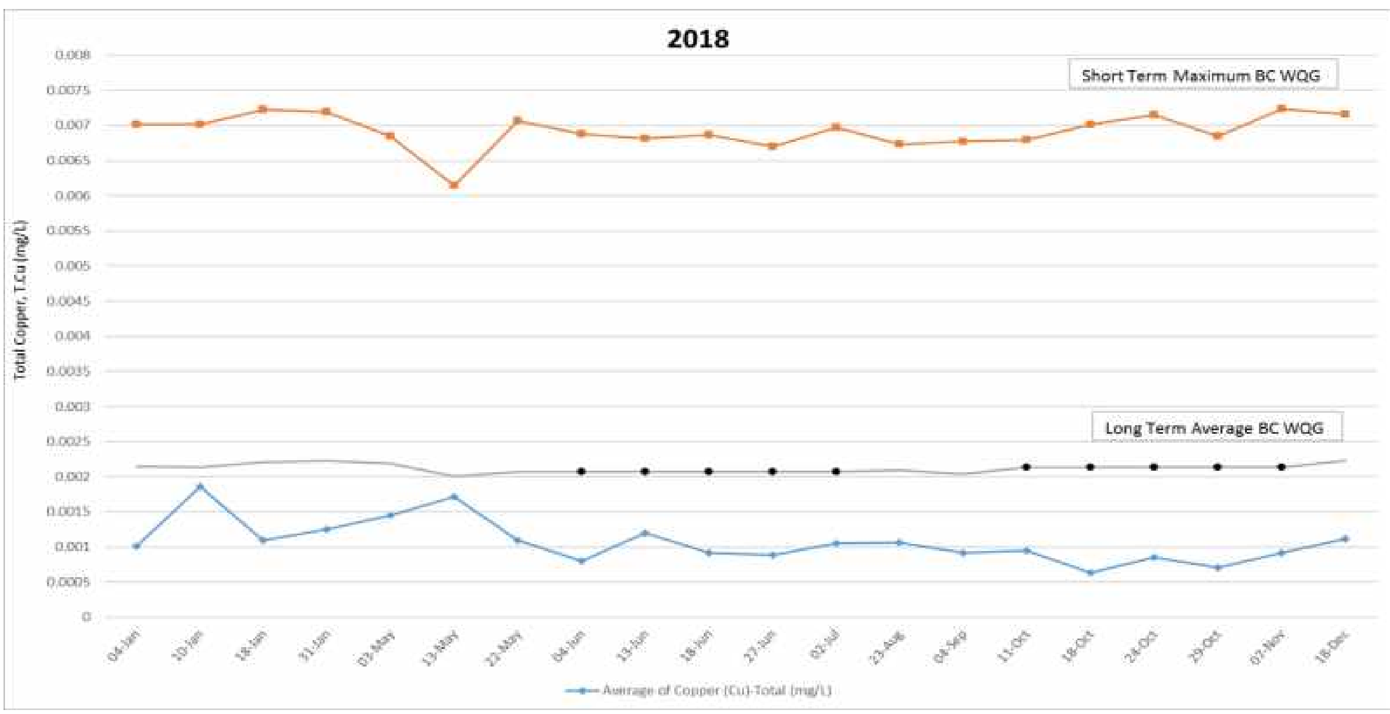

Figure 6.7 Short and long-term BC WQG for aquatic life total copper concentrations at QUL-58 in 2018. The black dots discern applicable long-term average BC WQG for aquatic life (5 samples in 30 days).

Historically, total phosphorus in Quesnel Lake and at QUL-58 has rarely met the BC WQG for aquatic life in lakes (where salmonids are the predominate fish species). The BC WQG limit ranges from 0.0050 mg/L to 0.0150 mg/L (ENV, 2018) and in 2018, the monthly mean results range from 0.0031 mg/L to 0.0129 mg/L at QUL-58 (the 0.0129 mg/L result was at the surface during a period of no discharge). While it has met the BC WQG during some sampling events, the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according to the BC WQG for total phosphorus – nutrients and algae [ENV, 2018]), therefore, total phosphorus remains below the BC WQG at an average of 0.0045 mg/L. This is expected as Quesnel Lake is an oligotrophic water body.

6.2.7 Receiving Environment Chemistry – Quesnel River

Quesnel River, site QUR-11, is sampled monthly by MPMC as a downstream site in the receiving environment according to the 2016 *CEMP*. Grab samples and in situ parameters are collected off the Likely Bridge using the Kemmerer sampler. The water chemistry results are compared to the BC WQG for aquatic life and all guidelines were met at QUR-11 in 2018. A total copper result from September 20, 2018 was elevated compared to previous results and was deemed as an outlier.

MPMC provides payment for a joint federal and provincial water quality monitoring site that is monitored at this same location. This sample is currently collected monthly and the data from the government sample are available on-line. Due to the ongoing sampling from this program, QUR-11 was removed as a monitoring site in the 2018 *CEMP*, therefore no samples were collected in November and December 2018.

6.3 Discharge Toxicity Testing Results

As per Section 3.3 of the *EMA* Permit 11678 issued on April 7, 2017 (amended October 2018), monthly acute toxicity testing is required at the discharge, location HAD-03. Further toxicity test sampling occurred as required by the 2016 *CEMP* and *MDMER*; testing was completed at Nautilus. No toxicity testing was completed at HAC-12 as the site no longer exists.

Table 6.4 Toxicity sampling events in 2018

Site Name	Site Identifier (EMS No.)	Test Type	Frequency	Actual Sampling Events
HAD-03	E304230	96-h rainbow trout LC50	Monthly	11[(a)]
		48-h *D. magna* LC50	Monthly	11
		7-d *C. dubia* survival and reproduction	Quarterly	4
		7-d rainbow trout embryo-alevin	Quarterly	3[(b)]
		72-h *P. subcapitata* growth inhibition	Bi-annually	3 [(c)]
		7-d *L. minor* growth inhibition	Bi-annually	3 [(c)]

(a) Monthly acute toxicity testing could not be completed in May as WTP was not discharging when testing was scheduled.

(b) No viable test media was available during the first quarter 2018. Document provided by Nautilus details issue (Appendix G).
(c) Additional sub-lethal testing was conducted to meet reporting criteria of *MDMER*.

6.3.1 Acute toxicity testing

Monthly acute toxicity testing occurred at HAD-03 throughout 2018, when the WTP was discharging (see Table 6.1). These tests were conducted on 100% (i.e. full strength) treated effluent in accordance with the following standard methods as required by *EMA* Permit 11678 and *MDMER*:

- 96-hour acute lethality to juvenile rainbow trout (procedures described by Environment Canada (2000a))
- 48-hour acute lethality to the water flea *D. magna* (procedures described by Environment Canada (2000b))

Acute toxicity tests of rainbow trout and *D. magna* both met the *EMA* Permit 11678 requirement of no acute toxicity by determining that the mortality was less than 50% in 100% effluent (results are provided in Appendix G).

6.3.2 Chronic toxicity testing

Chronic toxicity tests at HAD-03 (see Table 6.5) were conducted on 100% treated effluent according to the following standard methods as required by *EMA* and *MDMER* requirements:

- 7-day survival and reproduction of the water flea *C. dubia* (procedures described by Environment Canada (2000c))
- 7-day early life stage with salmonid (rainbow trout embryo-alevin) (procedures described by Environment Canada (1998))
- 7-day growth inhibition in the aquatic plant *Lemna minor* (procedures described by Environment Canada (2007b))
- 72-hour growth inhibition in the alga *Pseudokirchneriella subcapitata* (procedures described by Environment Canada (2007c)).

C.dubia and rainbow trout early life stage met the permit requirement of no chronic toxicity by determining that the inhibition of both tests was less than 25% (results are provided in Appendix G).

Effects were noted for both *P. subcapitata* and *L. minor* during the chronic toxicity testing in 2018. Stimulatory effects were observed for *P. subcapitata* cell yield; however, the IC25 and IC50 (%v/v) for cell yield were both >95.2. Inhibitory effects on frond growth and dry weight of *L. minor* were observed with an IC25 and IC50 (%v/v) for frond growth and dry weight.

7 Hazeltine Creek Environment Monitoring

7.1 Surface Water Monitoring

Water quality was monitored weekly and monthly at various sites throughout Hazeltine Creek in accordance with the 2016 and 2018 *CEMP* in 2018 (see Table 6.2). From January to April 25, 2018, flows in the creek were regulated by the Polley Lake weir structure. Fish were reintroduced into the upper remediated areas of Reach 1 and Reach 2 in Hazeltine Creek in April 26, 2018, and flow was constantly maintained. Physical barriers at the Gavin Lake Road Bridge and lower Hazeltine Creek prevented fish from entering as the creek underwent construction and remediation work in 2018.

Discharge from the WTP into Hazeltine Creek ceased in 2017; therefore no comparisons from the previous years' data will be made as the conditions have changed in 2018.

Hazeltine Creek water quality is provided in Appendix E.

Table 7.1 2018 sampling events in Hazeltine Creek

Site Name	Site Identifier (EMS No.)	Full Sample Suite Frequency 2016 *CEMP*	Full Sample Suite Frequency 2018 *CEMP*	Actual Sampling Events
HAC-01c	E303953	Weekly	Monthly	49
HAC-05a	E304510	Monthly	Monthly	27
HAC-08	E303013	Monthly	Monthly	26
HAC-10	E303010	Monthly	Monthly	28
HAC-14		N/A	Monthly[(a)]	34
HAC-13	E304810	Weekly	Monthly	45

(a) Monthly only from May to November - not accessible during winter months; was sampled weekly to acquire baseline.

7.1.1 BC WQG at HAC-10

HAC-10 is located immediately downstream of the Polley Lake weir. The weir was opened and closed from January to end of April to facilitate flows and freshet. As stated above, for the rest of 2018, the weir maintained opened for fish. Samples were collected monthly (with the exception of January, February, and April when collected weekly); therefore chronic BC WQG for aquatic life are not applicable, and these comparisons are for screening purposes only and are discussed below.

Table 7.2 Summary of acute BC WQG for aquatic life exceedances for aquatic life at HAC-10.

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-10	Total copper	2 exceedances	0.010-0.013[(a)]

Table 7.3 Summary of chronic BC WQG for aquatic life exceedances for aquatic life at HAC-10. This only applies during periods where five (5) samples were collected within 30 days.

Site	Parameter	Results	Chronic BC WQG (mg/L)
HAC-10	Dissolved aluminum	1 exceedance	0.05 mg/L
	Total copper	11 exceedances	0.004-0.008 [(a)]
	TSS	1 exceedance	5 mg/L change from background in 30 days
	Turbidity	1 exceedances	2 NTU change from background in 30 days

(a) Hardness dependent copper guideline; range given is based on hardness range at each site.

Total copper: There were two (2) acute BC WQG for aquatic life exceedances in May 2018. These exceedances corresponded with freshet. The maximum concentration was 0.0297 mg/L, with an annual average hardness of 125 mg/L and an annual total copper average of 0.006 mg/L. There were eleven (11) chronic exceedances from March to December.

Dissolved aluminum: There was no acute BC WQG for aquatic life exceedances in 2018 at HAC-01c. There was one (1) chronic BC WQG for aquatic life exceedance in May 2018, during freshet.

TSS: There was one (1) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 5 mg/L at any one time for a duration of 30 days occurred during the freshet period in May. The annual average was 2.4 mg/L with a maximum result of 23.6 mg/L in May.

Turbidity: There was one (1) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 2 NTU at any one time for a duration of 30 days occurred in during the freshet period in May. The annual average was 1.4 NTU with a maximum result of 12.0 NTU in May.

7.1.2 BC WQG at HAC-13

HAc-13 is located midway in Reach 1 in Upper Hazeltine Creek. Samples were collected weekly at this site (with the exception of November and December), therefore the chronic BC WQG for aquatic life are applicable.

Table 7.4 Summary of acute BC WQG for aquatic life exceedances for aquatic life at HAC-13.

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-13	Dissolved aluminum	1 exceedance	0.1
	Total copper	5 exceedances	0.010-0.029[(a)]
	Total iron	1 exceedance	1.0

Table 7.5 Summary of chronic BC WQG for aquatic life exceedances for aquatic life at HAC-13. This only applies during periods where five (5) samples were collected within 30 days

Site	Parameter	Results	Chronic BC WQG (mg/L)
HAC-13	Dissolved aluminum	1 exceedance	0.05 mg/L
	Total copper	26 exceedances	0.004-0.009 (a)
	Total chromium	5 exceedances	0.001 mg/L (b)
	Total selenium	1 exceedance	0.002 mg/L
	TSS	1 exceedance	5 mg/L change from background in 30 days
	Turbidity	1 exceedance	2 NTU change from background in 30 days

(a) Hardness dependent copper guideline; range given is based on hardness range at each site, when available.

(b) Based on the conservative BC working water quality guidelines (BC WWQG) for Chromium (Cr(VI)).

Dissolved aluminum: There was one (1) acute BC WQG for aquatic life exceedance in 2018 at HAC-13. The concentration was 1.19 mg/L in May, however this appears to be an error as the total aluminum concentration was 0.0514 mg/L. The lab QA/QC qualifier flagged the result as possibly contaminated during field filtration. The annual average was 0.032 mg/L. There were two (2) chronic BC WQG for aquatic life exceedances in 2018, both occurring in May.

Total copper: There were five (5) acute BC WQG for aquatic life exceedances in 2018. Four exceedances occurred during the freshet period in April and May, and the other one occurred during periods of heavy rain in November. The maximum concentration was 0.0561 mg/L in April, with an annual average hardness of 148 mg/L, and an annual total copper average of 0.011 mg/L. There were twenty-six (26) chronic exceedances from January to December. The exceedances above the chronic BC WQG have not shown to have any toxic effects on aquatic life (Section 7.1.6).

Total iron: There was one (1) acute BC WQG for aquatic life exceedances in 2018 in during the freshet period in April. The maximum result was 1.03 mg/L in April; the annual average of total iron was 0.069 mg/L.

Total chromium: There was one (1) chronic BC WQG for aquatic life exceedances in during the freshet period in April. The maximum result was 0.0016 mg/L in April; the annual average of total chromium was 0.0003 mg/L. Note that forty-four (44) out of forty-eight (48) results were below detection limit.

Total selenium: There was one (1) chronic BC WQG for aquatic life exceedances in during the freshet period in April. The maximum result was 0.0025 mg/L in April; the annual average of total selenium was 0.0007 mg/L. Total selenium has historically been elevated in Hazeltine Creek (details on water quality in Hazeltine Creek are presented in the *HHRA* (MPMC, 2017c) and *ERA* (MPMC, 2017d).

TSS: There was one (1) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 5 mg/L at any one time for a duration of 30 days occurred during the freshet period in April. The annual average was 1.5 mg/L with a maximum result of 23.9 mg/L in April.

Turbidity: There was one (1) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 2 NTU at any one time for a duration of 30 days occurred in during the freshet period in April. The annual average was 1.1 NTU with a maximum result of 15.6 NTU in April.

7.1.3 BC WQG at HAC-05a

HAC-05a is located upstream of the Gavin Lake road bridge. Samples were collected monthly (with the exception of January, February, and April when collected weekly); therefore chronic BC WQG for aquatic life are not applicable, and these comparisons are for screening purposes only and are discussed below.

Table 7.6 Summary of acute BC WQG for aquatic life exceedances for aquatic life at HAC-05a

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-05a	Total copper	4 exceedances	0.011-0.027[(a)]
	Total iron	1 exceedance	1.0

Table 7.7 Summary of chronic BC WQG for aquatic life exceedances for aquatic life at HAC-05a. This only applies during periods where five (5) samples were collected within 30 days

Site	Parameter	Results	Chronic BC WQG (mg/L)
HAC-05a	Total copper	26 exceedances	0.005-0.011 [(a)]
	Total chromium	1 exceedances	0.001 mg/L [(b)]
	Total selenium	5 exceedances	0.002 mg/L
	TSS	2 exceedances	5 mg/L change from background in 30 days
	Turbidity	3 exceedances	2 NTU change from background in 30 days

(a) Hardness dependent copper guideline; range given is based on hardness range at each site, when available.

(b) Based on the conservative BC WWQG for Chromium (Cr(VI)).

Total copper: There were four (4) acute BC WQG for aquatic life exceedances in 2018. Three exceedances occurred during the freshet period in April and May, and the other occurred during periods of heavy rain in November. The maximum concentration was 0.0484 mg/L in April, with an annual average hardness of 181 mg/L, and an annual total copper average of 0.014 mg/L. There were twenty-six (26) chronic exceedances from January to December. The exceedances above the chronic BC WQG have not been shown to have effects on aquatic life (Section 7.1.6).

Total iron: There was one (1) acute BC WQG for aquatic life exceedances in 2018 during the freshet period in 2018.

The maximum result was 1.09 mg/L in May; the annual average of total iron was 0.152 mg/L.

Total chromium: There was one (1) chronic BC WQG for aquatic life exceedances in during the freshet period in 2018. The maximum result was 0.0015 mg/L in May; the annual average of total chromium was 0.0004 mg/L. Twenty-one (21) out of twenty-seven (27) results were below detection limit.

Total selenium: There were five (5) chronic BC WQG for aquatic life exceedances in 2018. Three exceedances occurred in March, one (1) in April, and the other in September. The maximum result was 0.0025 mg/L in March; the annual average of total selenium was 0.0013 mg/L. Total selenium has historically been elevated in Hazeltine Creek (details on water quality in Hazeltine Creek are presented in the *HHRA* (MPMC, 2017c) and *ERA* (MPMC, 2017d).

TSS: There were two (2) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 5 mg/L at any one time for a duration of 30 days occurred during the freshet period in April and during a heavy rainfall period in November. The annual average was 3.6 mg/L with a maximum result of 34.9 mg/L in April.

Turbidity: There were three (3) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 2 NTU at any one time for a duration of 30 days occurred in during the freshet period in April and May, and during a heavy rainfall period in November. The annual average was 2.4 NTU with a maximum result of 19.5 NTU in April.

7.1.4 BC WQG at HAC-08

HAC-08 is located upstream of the Ditch Road bridge (on the Likely-Horsefly forest service road) at Lower Hazeltine Creek. Samples were collected monthly (with the exception of January, February, and April when collected weekly); therefore chronic BC WQG for aquatic life are not applicable, and these comparisons are for screening purposes only and are discussed below.

Table 7.8 Summary of acute BC WQG for aquatic life exceedances for aquatic life at HAC-08

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-08	Dissolved aluminum	2 exceedances	0.1
	Total copper	9 exceedances	0.010-0.029 [(a)]
	Total iron	4 exceedances	1.0

Table 7.9 Summary of chronic BC WQG for aquatic life exceedances for aquatic life at HAC-08. This only applies during periods where five (5) samples were collected within 30 days

Site	Parameter	Results	Chronic BC WQG (mg/L)
HAC-08	Dissolved aluminum	4 exceedances	0.05 mg/L
	Total copper	21 exceedances	0.004-0.009 [(a)]
	Total chromium	6 exceedances	0.001 mg/L [(b)]
	TSS	5 exceedances	5 mg/L change from background in 30 days
	Turbidity	5 exceedances	2 NTU change from background in 30 days

(a) Hardness dependent copper guideline; range given is based on hardness range at each site, when available.

(b) Based on the conservative BC WWQG for Chromium (Cr(VI)).

Dissolved aluminum: There were two (2) acute BC WQG for aquatic life exceedances in 2018. One (1) exceedance occurred in February, and the other occurred in November during periods of heavy rainfall. The maximum concentration was 0.155 mg/L with an annual average was 0.031 mg/L. There were four (4) chronic BC WQG for aquatic life exceedances and one (1) can be attributed to freshet in May, while rest can be attributed to the heavy rain events and subsequent precipitation that occurred in November and early December.

Total copper: There were nine (9) acute BC WQG for aquatic life exceedances in 2018. Six exceedances occurred during the freshet period in April and May, and the rest occurred during periods of heavy rain in November and early December. The maximum concentration was 0.0603 mg/L in April, with an annual average hardness of 178 mg/L, and an annual total copper average of 0.018 mg/L. There were twenty-one (21) chronic exceedances from January to December. The exceedances above the chronic BC WQG have not been shown to have effects on aquatic life (Section 7.1.6).

Total iron: There were four (4) acute BC WQG for aquatic life exceedances in 2018. Three occurred during the freshet period in April and May, while the other occurred during heavy rainfall periods in November. The maximum result was 2.62 mg/L in November; the annual average of total iron was 0.499 mg/L.

Total chromium: There was six (6) chronic BC WQG for aquatic life exceedances in 2018. Four occurred during the freshet period in April and May, while two occurred during heavy rainfall periods in November. The maximum result was 0.0028 mg/L in May; the annual average of total chromium was 0.0007 mg/L. Seventeen (17) out of twenty-six (26) results were below detection limit.

Total selenium: There were no chronic BC WQG for aquatic life exceedances in 2018.

TSS: There were five (5) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 5 mg/L at any one time for a duration of 30 days occurred in February, during the freshet period in April and May, during a heavy rainfall period in November. The annual average was 21.1 mg/L with a maximum result of 182 mg/L in April.

Turbidity: There were five (5) chronic BC WQG for aquatic life exceedance in 2018. Change from background of 2 NTU at any one time for a duration of 30 days occurred February, during the freshet period in April and May, during a heavy rainfall period in November. The annual average was 7.0 NTU with a maximum result of 46.3 NTU in November.

7.1.5 BC WQG at HAC-01c

HAC-01c replaced HAC-12 in late 2017 and is located approximately 150 m downstream of HAC-12. HAC-01c represents the outlet of Hazeltine Creek to Quesnel Lake without the influence of discharge from the WTP. The previous outlet location, HAC-12, was influenced by the WTP discharge and therefore, the previous years' water quality results are not comparable with those in 2018.

Twelve (12) acute (Table 7.10) and twenty-six (26) chronic (Table 7.11) BC WQG exceedances occurred at HAC-01c in 2018. Chronic exceedance is based on a 30-day average determined as the mean concentration of five evenly spaced samples collected over 30 days. More details on water quality in Hazeltine Creek from 2014 to 2016 are presented in the *HHRA* (MPMC, 2017c) and *ERA* (MPMC, 2017d), and previous years' *AERR*s.

Table 7.10 Summary of acute BC WQG for aquatic life exceedances for aquatic life at HAC-01c.

Site	Parameter	Results	Acute BC WQG (mg/L)
HAC-01c	Dissolved aluminum	1 exceedance	0.1
	Total copper	8 exceedances	0.011-0.027 (a)
	Total iron	3 exceedances	1.0

Table 7.11 Summary of chronic BC WQG for aquatic life at HAC-01c. This only applies during periods where five (5) samples were collected within 30 days.

Site	Parameter	Results	Chronic BC WQG (mg/L)
HAC-01c	Dissolved aluminum	3 exceedances	0.05 mg/L
	Total copper	47 exceedances	0.006-0.009 (a)
	Total chromium	5 exceedances	0.001 mg/L (b)
	Total selenium	1 exceedance	0.002 mg/L
	TSS	3 exceedances	5 mg/L change from background in 30 days
	Turbidity	7 exceedances	2 NTU change from background in 30 days

(a) Hardness dependent copper guideline; range given is based on hardness range at each site, when available.

(b) Based on the conservative BC WWQG for Chromium (Cr(VI)).

Dissolved aluminum: There was one (1) acute BC WQG for aquatic life exceedances in 2018 at HAC-01c. The exceedance occurred on November 6, 2018 following a heavy rain event, which also saw the maximum result recorded in 2018 at 0.134 mg/L. The annual average was 0.018 mg/L. There were three (3) chronic BC WQG for aquatic life exceedances in 2018 and can be attributed to the heavy rain event and subsequent precipitation that occurred in November and early December.

Total copper: There were eight (8) acute BC WQG for aquatic life exceedances in 2018. Five exceedances occurred during the freshet period, and the other three occurred during periods of heavy rain in the fall. The maximum concentration was 0.0391 mg/L in November, with an annual average hardness of 180 mg/L, and an annual total copper average of 0.013 mg/L. There were forty-seven (47) chronic exceedances from January to December. The exceedances above the chronic BC WQG have not shown to have any toxic effects on aquatic life (Section 7.1.6).

Total iron: There were three (3) acute BC WQG for aquatic life exceedances in 2018. Two out of the three occurred at the end of April and early May, during freshet. The maximum result was 1.97 mg/L in November; substantial rainfall occurred during the day and the days prior to this sampling event. The annual average of total iron was 0.278 mg/L.

Total chromium: There were five (5) chronic BC WQG for aquatic life exceedances in 2018. The maximum concentration in 2018 was 0.0022 mg/L during freshet. Three exceedances occurred during freshet, while the other two occurred during heavy rain events in November. The annual average total chromium was 0.00045 mg/L; note that forty-three (43) out of fifty-two (52) results were below detection limit.

Total selenium: There were no chronic BC WQG for aquatic life exceedance in 2018. The highest monthly average was in September with a concentration of 0.0018 mg/L. The annual average total selenium was 0.0011 mg/L with a maximum result of 0.0027 mg/L in September Total selenium has historically been elevated in Hazeltine Creek (details on water quality in Hazeltine Creek are presented in the *HHRA* (MPMC, 2017c) and *ERA* (MPMC, 2017d).

TSS: There were three (3) chronic BC WQG for aquatic life exceedances in 2018. Change from background of 5 mg/L at any one time for a duration of 30 days occurred in April, May, and November. Freshet caused the increase in TSS in April and May, and heavy rain events were the cause of the increase in November. The annual average was 4.7 mg/L with a maximum result of 54 mg/L in November.

Turbidity: There were seven (7) chronic BC WQG for aquatic life exceedances in 2018. Change from background of 2 NTU at any one time for a duration of 30 days occurred in April, May, June, and September through December. Freshet occurred in April, with residual effects seen in May; and heavy rain events throughout the fall appeared to trigger sporadic increases in turbidity. The annual average was 4.6 NTU with a maximum result of 52.1 NTU in November.

7.1.6 Toxicity testing at HAC-01c

Chronic toxicity was required by the *EMA* Permit 11678 at HAC-12; however, when the direct discharge pipeline was installed, that requirement was not extended to the new outlet of Hazeltine Creek to Quesnel Lake, HAC-01c (Appendix O). However, toxicity samples were collected as described in Table 7.12.

Table 7.12 Toxicity testing at HAC-01c in 2018.

Site Name	Site Identifier (EMS No.)	Test Type	Frequency	Actual Sampling Events
HAC-01c	E303953	96-h rainbow trout LC50	N/A	3
		48-h *D. magna* LC50	N/A	3
		7-d *C. dubia* survival and reproduction	Quarterly [(a)]	2
		7-d rainbow trout embryo-alevin	Quarterly [(a)]	1[(b)]

(a) Quarterly toxicity samples were specified for HAC-12; there is no permitted requirements for toxicity at HAC-01c.
(b) No viable test media was available during the first quarter 2018. Document provided by Nautilus details issue (Appendix G).

Samples for chronic toxicity tests (7-d *C. dubia* survival and reproduction and 7-d rainbow trout embryo-alevin) were collected in Quarter 1 2018. The rainbow trout eggs were not deemed viable by the lab, and the test could not be completed. Samples were collected during Quarter 2 2018 as part of the *MDMER EEM* bi-annual chronic (sublethal) toxicity requirements. *C.dubia* and rainbow trout early life stage met the Permit requirement of no chronic toxicity with >100% v/v.

Acute toxicity tests (96-h rainbow trout LC50 and 48-h *D. magna* LC50) were collected in May and December as a response to the acute BC WQG exceedances. The tests were not found to be acutely toxic.

7.1.7 Supplemental Sites: POF-1 and POF-5

Additional monitoring was continued in the Polley Flats to identify any potential influential sources seeping into Hazeltine Creek. Site POF-1 was established in 2016 and was sampled twenty-six (26) times in 2018. One (1) acute toxicity test, 96-h rainbow trout LC50 and 48-h *D. magna* LC50, was conducted in February 2018. The tests were not found to be acutely toxic (Appendix G). An addition source, POF-5, was established in summer 2017 and was sampled eight (8) times in 2018, and was dry the rest of the year therefore could not be sampled. Influence from these sites will be monitored by upstream and downstream samples of established sites in Hazeltine Creek in 2020. Sampling details are provided in Section 4.3 and the water quality is provided in Appendix F.

7.2 Groundwater

Following the TSF embankment breach an investigation of the groundwater quality in the Hazeltine Creek riparian area was conducted in 2015 to confirm the results of the geochemistry assessment conducted by SRK Consulting Inc. (SRK, 2015a). A second groundwater assessment was completed in 2016 in support of the risk assessments, and in 2017, a third assessment was completed by Golder. The 2017 assessment recommended one (1) more year of sampling which was completed in 2018. The Golder groundwater review (Appendix F) included a review of the 2016 to 2018 groundwater results but did not make recommendations and no trends were found. The results and discussion reading all three assessments are included in Appendix F.

7.3 Sediment

Bulk sediment sampling was conducted by Minnow in upper Hazeltine Creek in 2018 as part of the fish habitat survey. The purpose of the sampling was to evaluate the substrate chemistry as it relates to rainbow trout spawning in the remediated areas of upper Hazeltine Creek. These results are presented in the Minnow report provided in Appendix J.

7.4 Periphyton

Periphyton sampling was conducted by Minnow Environmental Inc. (Minnow) in Hazeltine, Frypan and Edney Creeks to meet the *CEMP* requirements (Appendix A). Periphyton biomass (ash-free-dry-mass), productivity (chlorophyll *a*), community samples, and tissue chemistry were collected for analysis in 2018. These results are presented in the Minnow report provided in Appendix J.

7.5 Benthic Invertebrate

Benthic invertebrate sampling was conducted by Minnow in Hazeltine, Frypan and Edney Creeks to meet the *CEMP* requirements (Appendix A). Benthic invertebrate total biomass, tissue quality, and community samples as well as composite taxa and single taxon (caddisfly) tissue samples were collected in upper Hazeltine, Edney, and Frypan Creeks in 2018. These results are presented in the Minnow report provided in Appendix J.

7.6 Fish and Habitat Surveys

Habitat assessments, habitat usage/density, and fish growth assessments were completed in Reach 1 and Reach 2 of Hazeltine Creek from May to October. Fry trapping and spot electrofishing were completed for collection of whole body rainbow trout tissue quality samples. Additional fry trapping was completed in Hazeltine and Frypan for collection of non-lethal meristics data. Discussion of these results will be presented in the Minnow report provided in Appendix J.

On April 27, 2018 after detailed studies and analysis, MPMC was authorized to move the fish exclusion fences from upstream of the Polley Lake weir to just above the Gavin Lake Road Bridge. This allowed the Polley Lake rainbow trout to return to the newly constructed spawning and rearing habitat in the approximately 2.6 kms of upper Hazeltine Creek. A detailed report on the return of rainbow trout will be issued under separate cover in early May 2019.

7.7 Fish Exclusion

In accordance with Section 2.6 of *EMA* Permit 11678 and the *Hazeltine Creek Fish Exclusion and Response Plan* (MPMC, 2016c), monthly visual inspections were conducted in 2018 (Table 7.13). Inspections included the length of Hazeltine creek from the fish exclusion fences to the Lower Settling Pond near Quesnel Lake, with the exception of the lower canyon during winter months due to safety concerns. Inspections were not completed in ice and snow covered conditions. Where fish were observed during inspections, minnow traps were used in an effort to remove the fish and return them to Polley Lake in accordance with Fish Collection Permit WL18-290183. Fry were observed downstream of the fish exclusion fences in July, August and October. Bottle and minnow traps were set in July but no fish were captured. In each case the fish were identified as longnose sucker, though not all of the individuals were clearly observed.

Table 7.13 Monthly Visual Fish Inspections of Hazeltine Creek results in 2018

Date of Inspection	Inspector	Inspection Results/Comments
09-Jan-18	VH, AA	Creek covered in ice and snow, no inspection
06-Feb-18	GH, AA	Creek covered in ice and snow, no inspection
08-Mar-18	TS, VH	Creek covered in ice and snow, no inspection
12-Apr-18	GH, TS	No fish observed, ~20 % ice covered, cleaned fish fence
04-May-18	GH	No fish observed.
08-Jun-18	TS, NS	No fish observed
17-Jul-18	GH, NS	Observed ~40 fry downstream of fish fences. Netted 3 that were identified as longnose sucker. Set 2 bottle traps. Observed 10-15 fish at drainage from Lower Sedimentation. Pond. No fish caught in traps.
22-Aug-18	GH	Observed 7 fry downstream of fish fences. Appear to be longnose sucker, no other fish observed.
14-Oct-18	GH	5 longnose sucker observed ~120m US of Upper Sedimentation Pond
21-Nov-18	TS, NS ,MK	No fish observed
10-Dec-18	GH, MK	Could not clean fish fences due to thick ice. No fish observed, pools mostly frozen. Channel downstream of construction experiencing significant ice accumulation.

7.8 Amphibian Hazard Assessment

Federal risk assessment guidance (FSCAP 2016) acknowledges there are gaps in the scientific literature and available assessment techniques that create a challenge for the meaningful risk evaluation of amphibians. In 2018, ENV accepted a proposal from MPMC for a tiered approach for evaluating risks to amphibians around Hazeltine Creek that builds on the existing ecological risk assessment. The first two tiers were completed in 2018 and recommendations were made regarding next steps. The findings and recommendations are detailed in *Amphibian Hazard Assessment Report* prepared by Golder which can be found in Appendix M and is summarized below.

7.8.1 Magnitude of Hazard

The work completed in 2018 provides a hazard evaluation for amphibians exposed to surface water and soils at the Mount Polley site. There are no readily available amphibian-specific toxicity reference values that have been endorsed by BC ENV or other relevant regulatory agencies, and therefore, it is not possible to conduct data screening in a routine manner like what can be done for other ecosystem components such as plants, soil invertebrates or aquatic organisms. Both federal and provincial risk assessment guidance allow for the derivation of a toxicity reference value using the available and applicable scientific literature under these circumstances. Golder derived a toxicity reference value of 0.018 mg/L dissolved copper for evaluating hazards associated with surface water, and 800 mg/kg copper for evaluating hazards associated with hydric soils or sediment. The available surface water and soil data for the Mount Polley site were compared to these conservative screening values, and overall, there was no evidence that environmental concentrations were routinely or notably higher than those screening value on a site-wide basis. Hazards to amphibians as a result of exposure to soil or surface water are considered to be low under these circumstances.

7.8.2 Implications for Monitoring

A hazard assessment does not typically lead to a "no further action required" unless all hazard quotients are less than 1. There are some areas where the hazard quotients appear to be consistently greater than 1 where additional monitoring specific to amphibians is warranted. The seepage zones and non-rehabilitated soil in the Polley Flats area are two specific areas for further monitoring. Conversely, the magnitude of the hazard elsewhere at the site was relatively low (i.e., less than a factor of 2) even though site-specific copper bioavailability was not considered.

The *ERA* had multiple lines of evidence that indicated that the bioavailability of copper from tailings was relatively low. It is not expected that copper bioavailability to amphibians would be substantially different in magnitude than that previously measured for soil invertebrates, plants, aquatic organism or wildlife receptors. Rather, the *ERA* indicated that impacts to those receptor populations and communities had occurred because of the habitat alteration implicit in the physical scouring and deposition of tailings. The nature of the tailings itself (i.e., low organic carbon; low water holding capacity; limited grain size diversity) was often a confounding factor in evaluating the risk associated with residual metals. The risk assessment identified that ecological succession would likely result in amelioration of those non-chemical stressors over time. Amphibians are expected to share a similar profile in that physical stressors and habitat alteration are present and likely more of an influence than residual metals associated with the tailings. The nature and level of effort for future monitoring or evaluation should be proportional to the magnitude of hazard described in this report in light of these overall risk assessment findings.

7.8.3 Recommended Next Steps

The focus of the terrestrial *CEMP* (which includes habitat used by adult amphibians) is to monitor natural ecological succession over time. Amphibians also utilize aquatic environments that are being monitored by *CEMP* components authored by other qualified professionals. A tiered strategy for evaluating risks to amphibians was originally described in the 2018 *CEMP*. The following recommendations are provided to assist MPMC integrate amphibian-specific monitoring activities into the overall *CEMP*:

- Most concentrations were either less than the screening value or within a factor of 2x. The next step according to the proposed tiered approach (see Appendix M) was to refine how the screening values are applied by measuring water and hydric soil copper concentrations in the specific areas that provide valued amphibian habitat. Golder concludes that this preliminary decision criteria is still relevant and recommends that a habitat survey be completed by a qualified biologist, followed by targeted soil, water and sediment sampling for any areas that are identified as providing valued habitat for amphibians.
- Additional evaluation of literature to refine the screening values is not recommended. The literature search summarized in this document was robust, and the applicable data were summarized and used as appropriate.
- Toxicity testing with amphibians is not recommended at this time. Separating the influence of chemical and non-chemical stressors was a challenge in both the plant and sediment invertebrate toxicity testing and this challenge is expected to be more problematic for amphibians. There is no approved Environment Canada protocol for toxicity testing with representative Canadian amphibian species. Protocols from other jurisdictions focus on the African clawed toad which is not meaningful for managing this site.
- Golder recommends that a structured approach could be used to measure population-level metrics (e.g., number of egg masses per unit area or abundance of amphibians per unit catch effort in the specific valued habitats identified on site). Biological monitoring may not be necessary if supplemental soil / sediment and surface water sampling shows that copper concentrations in valued amphibian habitat are less than the screening values. The tiered approach (Appendix A) deferred field-based effects assessment until the screening values were refined. Challenges associated with conducting "control-impact'" style measurements were described and continue to be a concern because there does not appear to be any "control" ponds that would have the same characteristics of on-site ponds in terms of habitat complexity, size, depth or other relevant factors. However, targeted monitoring of a few key metrics over time for on-site waterbodies would provide structure to the important site observation that amphibians appear to be successfully breeding on a year over year basis despite the presence of tailings and physical alteration of habitat.

7.9 Terrestrial Monitoring

In 2018, extensive terrestrial monitoring, under the supervision of QP's from Golder, continued in the Hazeltine Creek corridor. The data collected from this monitoring program was used to address some of the uncertainties from the *ERA* (MPMC 2017c). The data and analysis found that risks to wildlife associate with copper and vanadium in soils are low. Details of the terrestrial monitoring including the *Update to Wildlife Food Chain Model* are included in Appendix M.

7.10 Hydrology

In 2018, hydrological monitoring in Hazeltine Creek was completed at sites H1 (Upper Hazeltine Creek), H2 (Lower Hazeltine Creek) and H4 (Polley Lake outlet), as required by Section 3.4 of *EMA* Permit 11678 and the *CEMP* (Appendix A). Manual flow measurements were collected from April through December when flow rates were sufficient. Flow was controlled by the Polley Lake weir from January to the end of April and measurements are not indicative of the natural flow regime. After April 26, 2018, the flow rate in Hazeltine Creek was maintained due to the release of fish back into the remediated areas of upper Hazeltine Creek. From August to October, remediation work occurred below the Gavin Lake Bridge causing flow to be diverted from the H1 hydrology station.

Tables and figures presenting the 2018 hydrology results at all sites, including hydrographs, stage discharge rating curves, pressure-stage relations, goodness of fit statistics and photographs are presented in Appendix K. Recommendations from WaterSmith are included in Appendix K.

7.10.1 Site H1 - Upper Hazeltine Creek

Six (6) staff gauge readings and manual flow measurements were taken between May 21 and October 30, 2018. The highest manually measured discharge rate was 0.47 m^3/s on October 30, 2018.

Pressure transducer data from a PT2x were recorded from April 11 to November 22, 2018. There were no data gaps. The PT2x was removed in November due to freezing temperatures. An inspection was conducted by WaterSmith on July 30, 2018 and the review confirmed that the stilling well and staff gauge had been stable, and the water level data did not require adjustment.

A stage-discharge rating curve was developed to relate the staff gauge readings and the manual discharge measurements made in 2018, and a stage-pressure relation was developed between the manual staff gauge readings and the automated pressure data to allow application of the rating curve to the automated pressure data. From August to October, remediation work occurred below the Gavin Lake Bridge causing flow to be diverted from the H1 hydrology station. A rating curve shift may have occurred; possibly due to infilling of the substrates at the weir crest due to fish habitat construction, resulting in water levels being higher for a given discharge. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean difference of 20% and a standard error of 13%. The stage-discharge rating curve is provided in Appendix K.

Continuous records of stage and discharge values for the monitoring season were generated from PT2x data. Flow increased near the end of April due to the freshet and opening of the weir for fish. Flow peaked in November due to a heavy precipitation event. A general increase in flow at the end of August appears to signal a rating curve shift in the hydrological station. The highest calculated discharge rate was 2.48 m^3/s on November 3, 2018, however due to rating curve shift after August 24, the accurate highest calculated discharge rate was 0.091 m^3/s on April 27, 2018.

7.10.2 Site H2 - Lower Hazeltine Creek

Six (6) staff gauge readings and five (5) manual flow measurements were taken between April 10 and August 8, 2018. The highest manually measured discharge rate was 0.44 m^3/s on May 21, 2018.

Pressure transducer data from a PT2x were recorded from April 10 to November 26, 2018. The PT2x was removed in November due to freezing temperatures. An inspection was conducted by WaterSmith on July 30, 2018 and the review confirmed that the stilling well and staff gauge had been stable and the water level data did not require adjustment. The goodness of fit assessment yielded a mean difference of 18% and a standard error of 13%. The stage-discharge rating curve is provided in Appendix K.

Continuous records of stage and discharge for the monitoring season were generated from the pressure transducer data. Peak flow occurred in April, decreased in mid-May, and stayed low until early November when it increased again due to a heavy precipitation event. The highest calculated discharge rate was 1.78 m^3/s on April 27, 2018.

7.10.3 Site H4 - Polley Lake Weir

Thirty-eight (38) staff gauge readings and twenty-five (25) manual flow measurements were taken between April 10 and December 9, 2018. The highest measured discharge rate was 0.46 m^3/s on October 4, 2018.

Pressure transducer data from a PT2x were recorded from April 4 to October 5, 2018. Due to the installation of a fish ladder, the rock weir at the hydrology station required adjustment and was completed on August 1, 2018. The stilling well and staff gauge had been stable and the water level data did not require adjustment. However, due to the construction work completed in 2018, the stage-discharge curve from previous years are no longer applicable after August 1, 2018 and a new rating curve will need to be developed. An assessment of the goodness of fit of the manual readings to the pre- August 1, 2018 stage-discharge rating curve yielded a mean difference of 7.1% and a standard error of 7.1%. The stage-discharge rating curve is provided in Appendix K.

Continuous records of stage and discharge values for the monitoring season were generated from the PT2x data. Peak flow occurred in April during spring freshet. The periodic sudden decreases are due to weir adjustments and the fish ladder installation. Flow stabilized in late May and peaked again in mid-June as the weir was opened more to increase flow for the fish. The sudden shift in August is associated with the adjustment of the notch weir at the hydrology station to account for the fish ladder. The highest calculated discharge rate was 0.9 m^3/s on April 8, 2018 prior to the hydrology station adjustment.

7.11 Remediation

MPMC has been implementing a remediation strategy for the areas affected by the 2014 tailings dam failure over the last four (4) years that resulted in the removal of tailings from the Hazeltine Creek bed and surrounding areas. In 2018, a portion of Reach 3 (from HAC-05A downstream ~1 km; Appendix B) of middle Hazeltine Creek underwent channel reconstruction, fish habitat installation and floodplain contouring and seeding. The fish habitat consisted of riffle-pool morphology with irregularly spaced scour pools covered by large woody debris to provide rearing, spawning and overwintering environment for rainbow trout. Terrestrial objectives included surficial roughening as site preparation, to mitigate erosion and loosen soils. Planting will consist of planting live willow and black cottonwood wattles, prickly rose, black twinberry, red osier dogwood, Sitka alder and conifers, and a native seed blend (Table 10.3). Planting for this area is planned for spring 2019. The goal of this remediation is to return the ecosystem back into its ecological homeostasis, with the planting of native species and returning fish back in the upper areas of Hazeltine Creek. The restoration work for Reach 3 is planned to continue in 2019. Table 7.14 indicates the total plug stock stems planted, willow stakes and wattles planted, and grass seed used in the remediation effort to date.

Table 7.14 Hazeltine Creek Planting Summaries from 2015-2018

Plug Stock											
Year	**2015**			**2016**			**2017**			**2018**	
Locations	Lower HAC	Reach 2	Reach 3	Lower HAC	Reach 1	Reach 2	Lower HAC	Reach 1	Reach 2	All	Reach 1-3
Lodgepole Pine										51,240	
Douglas Fir	2,105									51,150	
Western Red Cedar										30,030	
Hybrid Spruce										60,060	
Black Cottonwood	3,510	930									
Trembling Aspen	530										
Paper Birch	400	130									
Saskatoon	530										
Prickly Rose	4,680		30,010	2,800	6,000	1,480		6,360	8,480		
Sitka Alder	3,140			38,040			22,190	7,630	41,310		56,800
Red Osier Dogwood	3,840		36,590	5,110	10,160	4,150			6,450		
Black Twinberry	1,300		13,800	3,430	5,240	900		2,050	10,510		
Common Juniper	36										
Soopolalie	36										
Scoulers Willow	5,450	290									
Total Planted Conifers Per Year	2,105			0			0			192,480	
Total Planted Shrubs/Decids Per Year	105,202			77,310			104,980			56,800	

Notes:
This table represents plug stock only
Table values derived from daily tracking and not delivery
Total delivery values greater than daily tracking indication ~2% of stock not accounted for
Discrepancy between delivered and tracked values likely to tracking errors

Total Conifers Planted to Date **194,585**
Total Planted Shrubs/Decids to Date **344,292**
Total Plug Stock Planting to Date **538,877**

Willows				
Year	**2015**	**2016**	**2017**	**2018**

Locations	Lower HAC	Lower HAC	Reach 1	Reach 2
Willow Species and Cottonwood				
Live Stakes	11,020	6,010	0	0
Wattles (m)	4,467	2,031	4,000	2,655
Notes:				
Live stakes 30-50cm in length		**Total live stakes planted**		**17,030**
Wattles full length pieces		**Total Wattles planted**		**13,153**
Planted by hand adjacent to water bodies				

Grass
~ 560 kg Native Grass Seed manually broadcast throughout entire breach affected area

Further information regarding remediation of the breach affected area to date is available on the IM website.

8 Aquatic Receiving Environment

8.1 Surface Water Quality

Surface water monitoring and analysis was conducted as outlined in the *CEMP*s (Appendix A). Refer to Section 4.3 for a discussion of field sampling equipment and methodology. Sampling stations and frequency are summarized in Table 8.1 and locations are shown in Appendix B.

Table 8.1 Sampling events in 2018 at surface water quality sites

Site	Site Identifier (EMS No.)	Frequency			
		2016 *CEMP*	**2018 *CEMP***	**Actual**	**Total**
W1	E225084	Monthly	Quarterly	12	12
W4a	E298551	Monthly	Monthly	12[b]	20
		Weekly [a]		8	
W5	E208039	Monthly	Monthly	10 [b,c]	18
		Weekly [a]		8	
W8	E216743	Quarterly	Quarterly	5	13
		Weekly [a]		8	
W8z	E223292	Quarterly	Quarterly	3[c]	3
W10	E291209	Monthly	Semi-annually	11[d]	11
EDC-01	E303014	Monthly	Semi-annually	12[d, e]	12
W12	E216744	Quarterly	Quarterly	5[e]	5
W20	E297070	Quarterly	Quarterly	2 [b,c]	2

[a] Weekly TSS and turbidity sampling for five (5) weeks during spring freshet and autumn low flows.
[b] Frozen in February 2018.
[c] Dry in August 2018.
[d] 2018 *CEMP* came into effect November 9, 2018.
[e] Sampled more than once in the same month.

Samples were submitted to ALS for analysis of:

- Physical parameters (pH, turbidity, TSS, total dissolved solids, and hardness);
- Anions and nutrients (alkalinity, chloride, fluoride, sulphate, total nitrogen, nitrate, nitrite, ammonia, phosphorus total and dissolved, and ortho-phosphorus);
- Organics (dissolved organic carbon); and
- Total and dissolved metals (metals suite as listed in *CEMP* Appendix A).

Water chemistry results from the surface sites were compared with the BC WQG for aquatic life for both short-term (maximum or acute) and long-term (chronic) exposures. In 2018, there were thirty-seven (37) exceedances of the acute BC WQG for aquatic life at the permitted surface water monitoring sites (Table 8.2). Note that the list of analytes with concentrations greater than BC WQG is similar to baseline. Exceedances for the chronic BC WQG for dissolved aluminum, total copper, total chromium and total selenium occurred at various sites, however, since only monthly or quarterly sampling is conducted at these sites, the required five samples taken in thirty days to calculate the average was not met. Therefore, these comparisons are for screening purposes only (Meays 2012) and are not listed in Table 8.2; they are described in the individual site sections below.

Prior to the TSF embankment breach elevated concentrations of selenium were observed in the mine's receiving environment (Minnow 2011, 2013a, b), and following the breach there were elevated selenium levels in impacted areas. MPMC is working with Minnow to monitor the selenium in the receiving environment to document special and temporal differences in concentrations and relationships among media. A summary report of data collected between 2009 and 2017 was provided in Appendix J of 2017 *AERR*, (MPMC 2018a).

At sites W4a, W5, and W8 weekly intensive sampling of TSS and turbidity occurred during spring (freshet) and fall (low flow period); and a 30-day average could be calculated; these were therefore appropriately compared to chronic TSS and turbidity BC WQG as summarized in Table 8.3. Additional details for each site are provided in the following sections and Appendix E (which includes tables of results for the past five years and graphs of select parameters). Note that only parameters with trends and/or exceedances are discussed the sections below. It was noted at time of publishing that the 95th percentile presented on the graphs may be incorrect; MPMC is working with the database provider to rectify this issue. Note that results below method detection limit (MDL) are represented as half (0.5x) the MDL in statistical calculations and graphs.

Table 8.2 Summary of acute BC WQG exceedances for aquatic life at surface water monitoring sites

Site	Parameter	Results	Acute BC WQG (mg/L)
W1	Dissolved aluminum	0.240 mg/L	0.1
	Total copper	4 exceedances – see Section 8.1.1	0.0054-0.0079[(a)]
W4a	Total copper	3 exceedances - see Section 8.1.2	0.0101-0.0114 [(a)]
W5	Dissolved aluminum	4 exceedances - see Section 8.1.3	0.1
	Total copper	6 exceedances - see Section 8.1.3	0.0044-0.0080 [(a)]
W8	Dissolved aluminum	0.146 mg/L; 0.222 mg/L	0.1
W8z	Dissolved aluminum	3 exceedances - see Section 8.1.5 for details	0.1
	Total copper	0.0052 mg/L; 0.00668 mg/L	0.0037; 0.0046 [(a)]
	Dissolved iron	0.389 mg/L	0.35
W12	Total copper	0.00966; 0.0137 mg/L	0.0072; 0.0078 [(a)]
W20	Dissolved aluminum	0.206 mg/L; 0.229 mg/L	0.1
	Total copper	0.00829 mg/L	0.0064[(a)]
W10	Dissolved aluminum	0.109 mg/L; 0.177 mg/L	0.1
EDC-01	Dissolved aluminum	0.107 mg/L; 0.172 mg/L	0.1
	Total copper	0.0063 mg/L	0.0058 [(a)]
	Total iron	1.05 mg/L	1.0

(a) Hardness dependent copper guideline; range given is based on hardness range at each site, when available.

Table 8.3 Summary of chronic BC WQG exceedances for aquatic life at surface water monitoring sites. This only applies to sites where five (5) samples were collected in 30 days.

Site	Parameter	Results	Chronic BC WQG (mg/L)
W4a	TSS	1 exceedance	5 mg/L change from background in 30 days
	Turbidity	1 exceedance	2 NTU change from background in 30 days
W5	TSS	1 exceedance	5 mg/L change from background in 30 days
	Turbidity	1 exceedance	2 NTU change from background in 30 days

8.1.1 Site W1 – Morehead Creek (E225084)

This site has been monitored since 1990. It was sampled eleven (11) times in 2018 and has been sampled thirty-eight (38) times over the past three years. There are no notable increasing or decreasing trends in water quality at this location. Graphs for a subset of parameters are provided in Appendix E.

Total copper: In 2018, monitoring results showed four (4) exceedances of acute BC WQG for copper. These type of exceedances have been observed since monitoring began in 1990 (before mining began). From 2016 to 2018 the minimum recorded value for copper was 0.00034 mg/L, the maximum was 0.0243 mg/L, and the mean was 0.0067 mg/L. The mean value for copper in 2018 was 0.0075 mg/L.

Dissolved aluminum: In 2018, monitoring results in November showed one (1) exceedance of the BC WQG for dissolved aluminum. This results appears to be an outlier (potentially a sampler or lab error) as it is the only observed exceedance for dissolved aluminum at this location, and there were no other elevated parameters observed in this sample. With the outlier of 0.24 mg/L removed the mean value for dissolved aluminum at W1 between 2016 and 2018 was 0.045 mg/L and the mean value since monitoring began is 0.041 mg/L.

Sulphate: A slight increase in sulphate levels has been recorded at W1 since 2005, though the levels remain well below any guidelines. From 2016 to 2018 the minimum recorded sulphate was 4.32 mg/L and the maximum was 30 mg/L with a mean of 8.99 mg/L. The mean for 2018 was 10.72 mg/L and the mean value since monitoring began is 6.39 mg/L.

Chloride: From 2016 to 2018 the minimum recorded chromium was 0.84 mg/L, the maximum was 118 mg/L and the mean was 8.71. The mean value for 2018 was 3.49 mg/L and the mean since monitoring began is 4.75 mg/L.

8.1.2 Site W4a – North Dump Creek below Wight Pit Road (E298551)

This site has been monitored since 2014. W4a was sampled twelve (12) times in 2018 for full metals suites and seven (6) times for turbidity and TSS only. Between 2016 and 2018 W4a has been sampled thirty-six (36) times for full metals suites and twenty-two (22) times for turbidity and TSS only, Graphs are provided in Appendix E. There was one (1) acute BC WQG and two (2) chronic BC WQG exceedance at this location in 2018. In comparison with previous years, there was one (1) exceedance in November 2014, two (2) in April and November 2015, one (1) in April 2016, and three (3) in April, May, and November 2017. The majority of exceedances have occurred during freshet in spring, however, during random periods of heavy rains in summer and fall, it is not uncommon to see spikes. There are no notable increasing or decreasing trends in water quality at this location.

Total copper: There were three (3) acute exceedances for total copper in 2018: 0.0172 mg/L in April, 0.0104 mg/L in May, and 0.0164 mg/L in November. In 2016 there was one (1) acute WQG exceedance and in 2017 there were three (1). Generally these exceedances correspond to elevated TSS in the sample. The elevated TSS is a result of a rainfall or run-off event. Between 2016 and 2018 the maximum concentration of copper recorded at W4a is 0.072 mg/L. The mean concentration between 2016 and 2018 is 0.011 mg/L and the mean for 2018 is 0.008 mg/L.

Dissolved aluminum: From 2016 to 2018 the minimum recorded dissolved aluminum is 0.003 mg/L, the maximum is 0.1 mg/L and the mean is 0.019 mg/L. In 2018 the mean is 0.022 mg/L.

TSS: In 2018 here was one (1) exceedance of the chronic BC WQG for TSS (table 8.3). Between 2016 and 2018 there were twelve (12) exceedances generally related to rainfall and runoff events. Between 2016 and 2018 the minimum value is <1.0 mg/L, the maximum is 138 mg/L and the mean is 10.22 mg/L. In 2018 the mean value is 4.02 mg/L.

Turbidity: In 2018 here was one (1) exceedance of the chronic BC WQG for turbidity (table 8.3). Between 2016 and 2018 there were four (4) exceedances generally related to rainfall and runoff events. Between 2016 and 2018 the minimum value is 0.18 NTU, the maximum is 145 NTU and the mean is 5.14 NTU. In 2018 the mean value is 1.43 NTU.

Total iron: Between 2016 and 2018 there was one (1) acute exceedance for total iron (in 2017) This exceedance may have had road runoff influence as the field notes express that the water was cloudy at the time of sampling. Between 2016 and 2018 the minimum value is 0.033 mg/L, the maximum is 1.49 mg/L and the mean is 0.224 mg/L. In 2018 the mean value is 0.202 mg/L.

Total selenium: From 2016 to 2018 the minimum recorded total selenium is 0.0005 mg/L, the maximum is 0.0098 mg/L and the mean is 0.0015 mg/L. In 2018 the mean is 0.002 mg/L.

8.1.3 Site W5 – Bootjack Creek (E208039)

This site has been monitored since 1990. It was sampled ten (10) times in 2018 for full metals suite and eight (8) times for TSS and turbidity only and has been sampled thirty-two (32) times for full metals suite and twenty-two (22) for TSS and turbidity only over the past three years. There was no flow observed at this site in July and December 2017, and February and August of 2018. There are no notable increasing or decreasing trends in water quality at this location. Graphs for a subset of parameters are provided in Appendix E.

Due to the TSF breach in August 2014, Bootjack Creek no longer flows directly to Hazeltine Creek resulting in a disconnection in fish habitat. In October 2014, fish were salvaged and are excluded from Bootjack Creek.

Sulphate: From 2016 to 2018 the minimum recorded sulphate was 1.22 mg/L and the maximum was 106 mg/L with a mean of 15.34 mg/L. The mean for 2018 was 16.72 mg/L and the mean value since monitoring began is 15.45 mg/L.

Dissolved aluminum: In 2018 there were four (4) exceedances of the acute BC WQG for dissolved aluminum at this location. Between 2016 and 2018 there have been fourteen (14) exceedances of the acute guideline for dissolved aluminum at this location. Dissolved aluminum has been elevated at this monitoring location since before the mine was established and there is no observed increasing trend. Between 2016 and 2018 the minimum value recorded is 0.007 mg/L, the maximum is 0.592 mg/L and the mean is 0.118 mg/L. The mean for 2018 is 0.129 mg/L.

Total copper: There were six (6) acute BC WQG exceedances of total copper in 2018. Between 2016 and 2018 there were seventeen (17) exceedances of the acute BC WQG at this location. As with dissolved aluminum, this site had elevated copper since before the mine was established and there is no observed increasing trend. Between 2016 and 2018 the minimum value recorded is 0.0012 mg/L, the maximum is 0.302 mg/L and the mean is 0.010 mg/L. The mean for 2018 is 0.012 mg/L.

TSS: In 2018 there was one (1) exceedance of the chronic BC WQG from the sample collected in April. Between 2016 and 2018 the minimum value recorded is <1.0 mg/L, the maximum is 10 mg/L and the mean is 2.53 mg/L. The mean for 2018 is 2.25 mg/L.

Turbidity: In 2018 there was one (1) exceedance of the chronic BC WQG from the sample collected in April. Between 2016 and 2018 the minimum value is 0.18 NTU, the maximum is 13.2 NTU and the mean is 2.07 NTU. In 2018 the mean value is 1.87 NTU.

8.1.4 Site W8 – Northeast Edney Creek Tributary (E216743)

This site has been monitored since 1995. It was sampled five (5) times in 2018 for full metals suite and eight (8) times for TSS and turbidity only and has been sampled fourteen (14) times for full metals suite and twenty-four (24) for

TSS and turbidity only over the past three years.

Dissolved aluminum: There were two (2) acute exceedance at this location in 2018. Between 2016 and 2018 there have been six (6) exceedances of the acute guideline for dissolved aluminum at this location. Dissolved aluminum has been elevated at this monitoring location since before the mine was established and there is no observed increasing trend. Between 2016 and 2018 the minimum value recorded is 0.0039 mg/L, the maximum is 0.231 mg/L and the mean is 0.085 mg/L. The mean for 2018 is 0.079 mg/L.

Total copper: Between 2016 and 2018 the minimum value recorded is 0.0007 mg/L, the maximum is 0.0087 mg/L and the mean is 0.0033 mg/L. The mean for 2018 is 0.0029 mg/L.

Total chromium: Between 2016 and 2018 the minimum value recorded is 0.0005 mg/L, the maximum is 0.0015 mg/L and the mean is 0.0009 mg/L. The mean for 2018 is 0.0008 mg/L.

TSS: Between 2016 and 2018 the minimum value recorded is 1.1 mg/L, the maximum is 26.5 mg/L and the mean is 3.86 mg/L. The mean for 2018 is 1.78 mg/L.

Turbidity: Between 2016 and 2018 the minimum value recorded is 0.22 NTU, the maximum is 3.04 NTU and the mean is 1.15 NTU. The mean for 2018 is 0.80 NTU.

8.1.5 Site W8z – Southwest Edney Creek Tributary (E223292)

This site has been monitored since 1997. It was sampled three (3) times in 2018 and has been sampled nine (9) over the past three years.

Dissolved aluminum: There were three (3) acute BC WQG exceedances at this location in 2018. All samples collected at this location since 1997 have exceeded the BC WQG for dissolved aluminum. Between 2016 and 2018 the minimum value recorded is 0.187 mg/L, the maximum is 0.406 mg/L and the mean is 0.262 mg/L. The mean for 2018 is 0.245mg/L.

Total copper: There were two (2) acute BC WQG exceedances at this location in 2018. Between 2016 and 2018 there have been four (4) exceedances of the acute guideline for total copper at this location. As with dissolved aluminum, this site had elevated copper since before the mine was established and there is no observed increasing trend. Between 2016 and 2018 the minimum value recorded is 0.0032 mg/L, the maximum is 0.0067 mg/L and the mean is 0.0051 mg/L. The mean for 2018 is 0.0057 mg/L.

Dissolved iron: There was one (1) acute exceedance at this location. Between 2016 and 2018 there have been four (4) exceedances of the acute guideline for dissolved iron at this location. As with dissolved aluminum, this site had elevated dissolved iron since before the mine was established and there is no observed increasing trend. Between

2016 and 2018 the minimum value recorded is 0.157 mg/L, the maximum is 0.568 mg/L and the mean is 0.309 mg/L. The mean for 2018 is 0.273 mg/L.

Total chromium: In 2018 there were three (3) acute exceedances at this location. As with many sites and many parameters the water at this site is naturally elevated with chromium and almost always exceeds the BC WQG. Between 2016 and 2018 the minimum value recorded is 0.0009 mg/L, the maximum is 0.0018 mg/L and the mean is 0.0015 mg/L. The mean for 2018 is 0.0015 mg/L.

TSS: Between 2016 and 2018 the minimum value recorded is <1.0 mg/L, the maximum is 1.0 mg/L and the mean is 1.0 mg/L. The mean for 2018 is 1.0 mg/L.

Turbidity: Between 2016 and 2018 the minimum value recorded is 0.69 NTU, the maximum is 2.65 NTU and the mean is 1.46 NTU. The mean for 2018 is 1.19 NTU.

8.1.6 Site W10 – Edney Creek (E291209)

Prior to this becoming a permitted site there were only a few samples collected here since 1995. This site is a reference site, selected for comparisons to the sites downstream from the mine disturbance, including a site in the re-engineered channel of Edney Creek. Graphs are provided in Appendix E. This site was sampled eleven (11) times in 2018. There was no access to this sample location in December.

Dissolved aluminum: There were two (2) acute BC WQG exceedances at this site in 2018 and twelve (12) exceedances of BWQG between 2016 and 2018. This site has had elevated dissolved aluminum since before the mine was established and there is no observed increasing trend. Between 2016 and 2018 the minimum value recorded is 0.0033 mg/L, the maximum is 0.202 mg/L and the mean is 0.058 mg/L. The mean for 2018 is 0.035 mg/L.

Total copper: There were no acute BC WQG exceedances at this site in 2018. Between 2016 and 2018 the minimum value recorded is 0.0009 mg/L, the maximum is 0.0045 mg/L and the mean is 0.0025 mg/L. The mean for 2018 is 0.0025 mg/L.

Total chromium: Between 2016 and 2018 the minimum value recorded is 0.0006 mg/L, the maximum is 0.0016 mg/L and the mean is 0.0010 mg/L. The mean for 2018 is 0.0013 mg/L.

TSS: Between 2016 and 2018 the minimum value recorded is <1.0 mg/L, the maximum is 27.1 mg/L and the mean is 6.1 mg/L. The mean for 2018 is 7.1 mg/L.

Turbidity: Between 2016 and 2018 the minimum value recorded is 0.1 NTU, the maximum is 7.38 NTU and the mean is 1.78 NTU. The mean for 2018 is 1.27 NTU.

8.1.7 Site EDC-01 – Edney Creek below constructed channel (E303014)

Located just upstream of the mouth of the creek near Quesnel Lake, this site was established in February 2015 after the newly constructed Edney Channel was completed and opened to fish passage. This site is used to monitor any potential impacts on Edney Creek from the new construction. This site was sampled for twelve (12) times in 2018. Considering W10 as the background site for Edney Creek, the following observations are noted:

Dissolved aluminum: There were two (2) acute BC WQG exceedances at this site in 2018 and six (6) exceedances between 2016 and 2018. Between 2016 and 2018 the minimum value recorded is 0.003 mg/L, the maximum is 0.172 mg/L and the mean is 0.053mg/L. The mean for 2018 is 0.035 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Total copper: There was one (1) acute BC WQG exceedances at this site in 2018 and one (1) in 2016. Between 2016 and 2018 the minimum value recorded is 0.002 mg/L, the maximum is 0.0085 mg/L and the mean is 0.0044mg/L. The mean for 2018 is 0.0048 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Total iron: There was one (1) acute BC WQG exceedances at this site in 2018. Between 2016 and 2018 the minimum value recorded is 0.044 mg/L, the maximum is 1.10 mg/L and the mean is 0.296 mg/L. The mean for 2018 is 0.229 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Total chromium: Between 2016 and 2018 the minimum value recorded is 0.00054 mg/L, the maximum is 0.002 mg/L and the mean is 0.0010 mg/L. The mean for 2018 is 0.001 mg/L. Comparing these results to W10, the levels of chromium at EDC-01 were similar.

Sulphate: Results were above sulphate levels at W10 for much of the year, but remained well below the BC WQG. Between 2016 and 2018 the minimum value recorded is 1.33 mg/L, the maximum is 65.4 mg/L and the mean is 16.49 mg/L. The mean for 2018 is 22.17 mg/L.

TSS: Between 2016 and 2018 the minimum value recorded is <1.0 mg/L, the maximum is 26.7 mg/L and the mean is 6.37 mg/L. The mean for 2018 is 10.47 mg/L. Comparing these results to W10, the levels at EDC-01 were similar.

Turbidity: Between 2016 and 2018 the minimum value recorded is 0.17 NTU, the maximum is 10.9 NTU and the mean is 2.25 NTU. The mean for 2018 is 1.39 NTU. Comparing these results to W10, the levels at EDC-01 were similar.

8.1.8 Site W12 – 6K Creek at Road (E216744)

This site has been monitored since 1990. It was sampled four (4) times in 2018 and has been sampled eleven (11) times over the past three years. There are no notable increasing or decreasing trends in water quality at this location. Graphs for a subset of parameters are provided in Appendix E.

Total copper: There was one (1) acute BC WQG exceedances at this site in 2018. Between 2016 and 2018 the minimum value recorded is 0.0024 mg/L, the maximum is 0.0137 mg/L and the mean is 0.0060 mg/L. The mean for 2018 is 0.0076 mg/L. This site had elevated copper since before the mine was established.

Dissolved aluminum: Between 2016 and 2018 the minimum value recorded is 0.0041 mg/L, the maximum is 0.0957 mg/L and the mean is 0.0299 mg/L. The mean for 2018 is 0.0374 mg/L.

Sulphate: A slight increase in sulphate levels has been recorded at W12 since 2005, though the levels remain well below any guidelines. From 2016 to 2018 the minimum recorded sulphate was 3.73 mg/L and the maximum was 61.6 mg/L with a mean of 21.75 mg/L. The mean for 2018 was 22.41 mg/L and the mean value since monitoring began is 9.56 mg/L.

TSS: Between 2016 and 2018 the minimum value recorded is <1.0 mg/L, the maximum is 10.0 mg/L and the mean is 3.4 mg/L. The mean for 2018 is 3.1 mg/L.

Turbidity: Between 2016 and 2018 the minimum value recorded is 0.55 NTU, the maximum is 2.63 NTU and the mean is 1.25 NTU. The mean for 2018 is 1.54 NTU.

8.1.9 Site W20 – W20 Creek (E297070)

This site has been monitored since 2013 when the West Ditch was constructed. In 2018 two (2) samples were collected. There have been no trends or notable changes in water quality at this location. Graphs for a subset of parameters are provided in Appendix E.

Dissolved aluminum: There were two (2) acute exceedance at this location in 2018. Most samples at this location have high dissolved results. Between 2016 and 2018 the minimum value recorded is 0.0594 mg/L, the maximum is 0.229 mg/L and the mean is 0.159 mg/L. The mean for 2018 is 0.218 mg/L.

Total copper: There was one (1) acute BC WQG exceedances at this site in 2018. Between 2016 and 2018 the minimum value recorded is 0.00389 mg/L, the maximum is 0.00829 mg/L and the mean is 0.0063 mg/L. The mean for 2018 is 0.0078 mg/L.

8.2 Lake Sampling

In 2018, lake sampling was completed as outlined in the 2016 and 2018 *CEMP* in Appendix A (Table 8.4). Refer to Section 4.3 for a discussion of field sampling equipment and methodology and Appendix B for site map.

Appendix L includes tables of all results for the past five years and graphs of the parameters measured.

Table 8.4 Lake water quality sampling locations in 2018

Site	Site Identifier (EMS No.)	Profile Frequency		Sample Frequency	
		CEMP	Actual	Permit Requirement	Actual
P1	E207974	Bi-monthly[(a)]	14	Monthly	10
P2	E207975	Bi-monthly[(a)]	15	Monthly	11
B1	E207972	Bi-monthly[(a)]	9	Bi-annually	2
B2	E215897	Bi-monthly[(a)]	11	Bi-annually	2
B4	E216744	Bi-monthly[(a)]	9	-	-
QUL-ZOO-1	E306455	Bi-annually	2	Bi-annually	2
QUL-ZOO-7	E306456	Bi-annually	2	Bi-annually	2
QUL-ZOO-8	E306457	Bi-annually	2	Bi-annually	2
QUL-2a	E303020	Monthly [(b,c)]	6	Monthly [(b,c)]	6
QUL-18	E303019	Monthly [(b,c)]	7	Monthly [(b,c)]	7
QUL-120a	E303022	Seasonally	4	Seasonally	4

[(a)] During spring & fall turnover only as per 2016 *CEMP*

[(b)] Monitoring is only conducted twice during winter at these sites as per 2016 *CEMP*

[(c)] Changed to four times a year on November 9, 2018 as per 2018 *CEMP*

8.2.1 Bootjack Lake

In Bootjack Lake, station B1 is located at the northwest end of the lake and station B2 is located at the southeast end. It was discovered that in late 2016, the previous stations were not at the deepest locations for the 2016 monitoring season and these sites were relocated to the deepest areas for monitoring in 2017, and continued in 2018. Sampling occurred during spring turnover in May and in late summer in August. Limnological profiles were taken bi-monthly between spring and fall turnover at B2; however profiles were missed at B1 once in May and September. Profile and chemistry data are presented in Appendix L.

In 2016, four (4) locations (B3, B4, B5, and B6) were created near areas of potential exfiltration from the Springer Pit supernatant. Based on the 2016 results it was determined in 2017 that one (1) location, B4, would be profiled bi-monthly, as the Springer Pit supernatant is well below the recommended 1030 masl (Golder, 2016a). This monitoring continued in 2018. Limnological profiles were collected bi-monthly with the exception of May and September when only one (1) profile was taken.

8.2.1.1 In Situ Data

In 2018, MPMC recorded profile data at B1 and B2 nine (9) times. B2 was profiled another two times by Minnow to correspond with their sampling program. Limnological profiles of pH, conductivity, dissolved oxygen, turbidity, and temperature as well as Secchi depth were measured at B1 and B2 from May to October 2018. During the lake turnover events in spring and fall 2018 as well as throughout the year, field parameters were consistent with previous years.

Profiles were also measured at B4 between May and October. No noticeable increases of any parameter were identified at this additional site. Investigations were conducted using specific conductivity to locate areas of possible exfiltration from the Springer Pit supernatant at various depths. According to Golder, (2017a), as the Springer Pit level has drastically decreased since June 2016 it has become a groundwater sink in both upgradient and downgradient groundwater and therefore the results of no exfiltration detected in Bootjack Lake are expected.

8.2.1.2 Lake Water Chemistry

Water samples for analytical chemistry were collected at surface, bottom, and every 10 m when the lake is isothermal and at surface, bottom, and every 5 m when the lake is not isothermal at sites B1 and B2. Appendix L contains water chemistry data tables with results from the last five years.

Bootjack Lake has been routinely sampled for water quality twice a year in during spring turnover and late August. In 2017, total iron, total manganese, and total phosphorus levels exceeded aquatic BC WQGs for samples collected near the bottom of B1 and B2 during sampling events in September, due to conditions at the bottom becoming anoxic with the fall turnover. Historically, MPMC has not sampled during fall turnover on Bootjack Lake and therefore did not have baseline data for comparison. Late August does appear to signal the start of the anoxic conditions associated with fall turnover seen in 2017, with B1 changing earlier than B2, possibly due to its slightly shallower depth. The water quality from 2018 is consistent with this trend, as subtle increases of total manganese and total iron were noticed in August. There are no other significant changes in water chemistry in Bootjack Lake.

8.2.2 Polley Lake

In Polley Lake, station P1 is located at the deepest point at the north end of Polley Lake and station P2 is located at the deepest point at the south end of Polley Lake and are shown in Appendix A. Sampling occurred monthly between spring and fall overturn; limnological profiles were conducted bi-monthly along with the Secchi depth during the same period as per *CEMP* (Appendix A). Only one (1) sampling event occurred in winter 2018 at P1 and P2. Profile and chemistry data are presented in Appendix L.

Polley Lake was impacted by the TSF embankment breach that occurred in 2014 (MPMC, 2015a) and sample results for water quality show that some water chemistry results are elevated from historic and baseline levels. All results are included in Appendix L.

8.2.2.1 In Situ Data

In 2018, MPMC recorded profile data at P1 and P2 fourteen (14) times. Profiles of pH, specific conductivity, dissolved oxygen, turbidity and temperature were measured at P1 and P2 twice a month in June, July, August, September, October, and November 2018; only profile was completed in May as spring lake turnover had not occurred. During the lake turnover events in spring and fall 2018 as well as throughout the year, field parameters were consistent with previous post-breach years.

In Polley Lake, conductivity historically ranged from 121 to 215 µS/cm, with an average of 186 µS/cm. Following the breach, the conductivity increased to a maximum of 410 µS/cm at P1 and 396.9 µS/cm at P2 in September 2015, with an average of 284.2 µS/cm. Conductivity throughout Polley Lake appears to be decreasing slightly since the breach; however, it remains above historic levels. In 2018, the average conductivity recorded at P1 was 277 µS/cm and at P2 was 276 µS/cm, which is similar to 2017, and 2016, but lower than 2015.

In Polley Lake, pH historically ranged between 6.9 and 9.55 with an average of 8.27 at P1 and from 7.12 and 9.55 with an average of 8.34 at P2. Following the breach, pH remains similar with a range of 6.72 to 8.75 at P1 with an average of 7.74 and from 6.7 to 8.79 with an average of 7.83 at P2.

8.2.2.2 Water Chemistry

In 2018, water samples for analytical chemistry were collected at surface, bottom, and every 5 m when conditions were not isothermal and every 10 m when isothermal at sites P1 and P2. These data are presented in Appendix L.

Polley Lake has met all BC WQG for aquatic life parameters in 2018 with the exception of total phosphorus, which has been elevated since prior to mining. Some trending parameters are discussed below:

Total copper: Copper concentrations have been higher since 2014 with an average of 0.0043 mg/L compared with the average of 0.0023 mg/L pre-breach. In 2018, the maximum total copper concentration recorded was 0.0103 mg/L, which was similar to 2017 with 0.0104 mg/L but higher than 2016 and 2015 (0.0079 mg/L and 0.0068 mg/L respectively).

Total selenium: Selenium concentrations have decreased to below pre-breach. The pre-breach average was 0.0009 mg/L compared to 0.0007 mg/L in the years after 2014. The maximum recorded in 2018 was 0.0006 mg/L and an average of 0.0005 mg/L. While an initial increase was noted following the breach with a maximum of 0.0012 mg/L, the downward trend was obvious, in 2015, 2016, and 2017 with maximum concentrations of 0.0011 mg/L, 0.008 mg/L, and 0.007 mg/L respectively.

Minnow has installed DGTs in Polley Lake since 2015, and have provided memos that have been appended to previous years' annual reports (MPMC 2016b, 2017e). According to Minnow, total and dissolved metals over-represent the metal fraction that is potentially available for uptake by aquatic organisms in natural surface waters. Minnow's technical memos describes the methods and results for the DGT deployments. Key findings for Polley Lake include that mean DGT-labile copper concentrations are very low, however they are higher than in Bootjack Lake (reference), and DGT labile concentrations in Polley Lake of arsenic, molybdenum, selenium and vanadium were enriched compared to Bootjack Lake. However, total concentrations of these metals were below the BC WQG.

8.2.3 Quesnel Lake

8.2.3.1 Quesnel Lake Zooplankton Sites

In Quesnel Lake, site QUL-ZOO-1 is located in the centre of the West Basin, QUL-ZOO-7 is located in front of Horsefly Bay, and QUL-ZOO-8 is located at the junction of the North, East and West Arms (Appendix B). Sampling and limnological profiles occurred bi-annually as per the *CEMP* (Appendix A). In 2018, samples were collected in June and September; sampling was not able to be completed in August due to unsafe conditions caused by forest fires in the area. There were no acute BC WQG exceedances at these sites in 2018. MPMC continues to collect profile and surface water quality data from these sites to be used in the analysis of plankton results (see Section 8.6).

8.2.3.2 Quesnel Lake Receiving Environment and Reference Sites

According to the 2016 *CEMP*, the far-field receiving environment in Quesnel Lake are monitored at QUL-18 (the deepest area of the West Basin, downstream far-field exposure station) and QUL-2a (West Basin upstream of the mouth of Hazeltine Creek; to monitor for potential eastward flow of effluent due to seiche events). Sampling and limnological profiles at depths occurred monthly (Appendix A) with the exception of August at QUL-2a due to the proximity of forest fires in the area.

An upstream reference station, QUL-120a, is located east of Cariboo Island. Sampling and limnological profiles at depths outlined in the 2016 *CEMP* (Appendix A), occurred seasonally during May, June, August, and October 2018. May was considered 'winter' as the Quesnel Lake had not undergone spring turnover at that location when monitored. Sampling and limnological profiles occurred in June and August to coincide with zooplankton sampling events.

The *ADP* in 2018 identified no significant differences in water quality between QUL-2a and QUL-120a. This analysis spearheaded the change for the background water quality reference site from QUL-120a to QUL-2a. Location QUL-2a also poses less of a safety risk and is the closest upgradient site the discharge and water quality at a depth of 40m was shown a greater representation of what would be measured at the IDZ (MPMC, 2018b; Appendix H). This change was reflected in the 2018 *CEMP*.

8.2.3.2.1 Lake Water Chemistry

Quesnel Lake is an oligotrophic lake, therefore, it is common to see total phosphorus concentrations lower than the BC WQG, as was observed at all sites in Quesnel Lake (Appendix L), with the exception of certain locations discussed below. No acute BC WQG exceedances were found in any of the receiving environment sites for 2018. Exceedances for the chronic BC WQG for total copper, and total chromium occurred, however, since only monthly or seasonal sampling is conducted at QUL-18, QUL-2a, and QUL-120a, the required five samples taken in thirty (30) days to calculate the average was not met. Therefore, these comparisons are for screening purposes only and are discussed below. Additional information related to the discharge water quality are in Section 6.2 and discharge plume modeling in Quesnel Lake are in Appendix I.

At QUL-18 in 2018, there were no observed changes or trends in the water quality at this site in 2018. However, an increase in total phosphorus at the surface, 20m, and 50m depth (0.141 mg/L, 0.097 mg/L, and 0.046 mg/L respectively) in late August was noted. This may be due to remnants of spawning and debris from the wildfires; the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according the BC WQG for total phosphorus – nutrients and algae), therefore, total phosphorus remains in compliance with the BC WQG. The average of total phosphorus in 2018 at QUL-18 was 0.017 mg/L and the maximum concentration was 0.141 mg/L throughout the water column (Figure 8.1). There was one (1) instance of total copper exceeding the chronic BC WQG at 100 m depth in August. Concentrations have exceeded chronic limits at a 100 depth once in April 2017 and three times in 2016 (May, June, and November); and once at 20 m depth in November 2016 (Figure 8.2). The average of total copper in 2018 at QUL-18 was 0.0010 mg/L and the maximum concentration was 0.0021 mg/L throughout the water column.

At QUL-2a, there were no observed changes or trends in the water quality at this site in 2018. However, one (1) higher total phosphorus concentration (0.0488 mg/L) occurred at the surface in May in 2018. Observations collected during the sample event noted an abundance of pollen on the surface (Figure 8.1). The working BC WQG for total chromium was exceeded at QUL-2a-60m in September with a result of 0.0019 mg/L (note this sample result appears to be an outlier, potentially from a contaminated sample vessel or sampling error as all other sample results for this site are below the detection limit of 0.0005 mg/L). There were two (2) instances of total copper exceeding the chronic BC WQG at surface and at 40 m depth in July. The only one (1) other time has a result exceeded the chronic limit occurred at 60 m depth in May 2016 (Figure 8.4). The average of total copper in 2018 at QUL-2a was 0.0010 mg/L and the maximum concentration was 0.0039 mg/L throughout the water column.

At QUL-120a, there were no observed changes or trends in the water quality at this site. However, an increase in total phosphorus at 120m and 140m depth in late August (0.0436 mg/L and 0.077 mg/L respectively) was noted. This may be due to remnants of spawning and debris from the wildfires; the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according the BC WQG for total phosphorus – nutrients and algae), therefore, total phosphorus remains in compliance with the BWQG (Figure 8.1). Copper results remain below BC WQG at QUL-120a (Figure 8.3). There were no trends observed and no acute or chronic exceedances were found at QUL-120a in the 2018 sampling events.

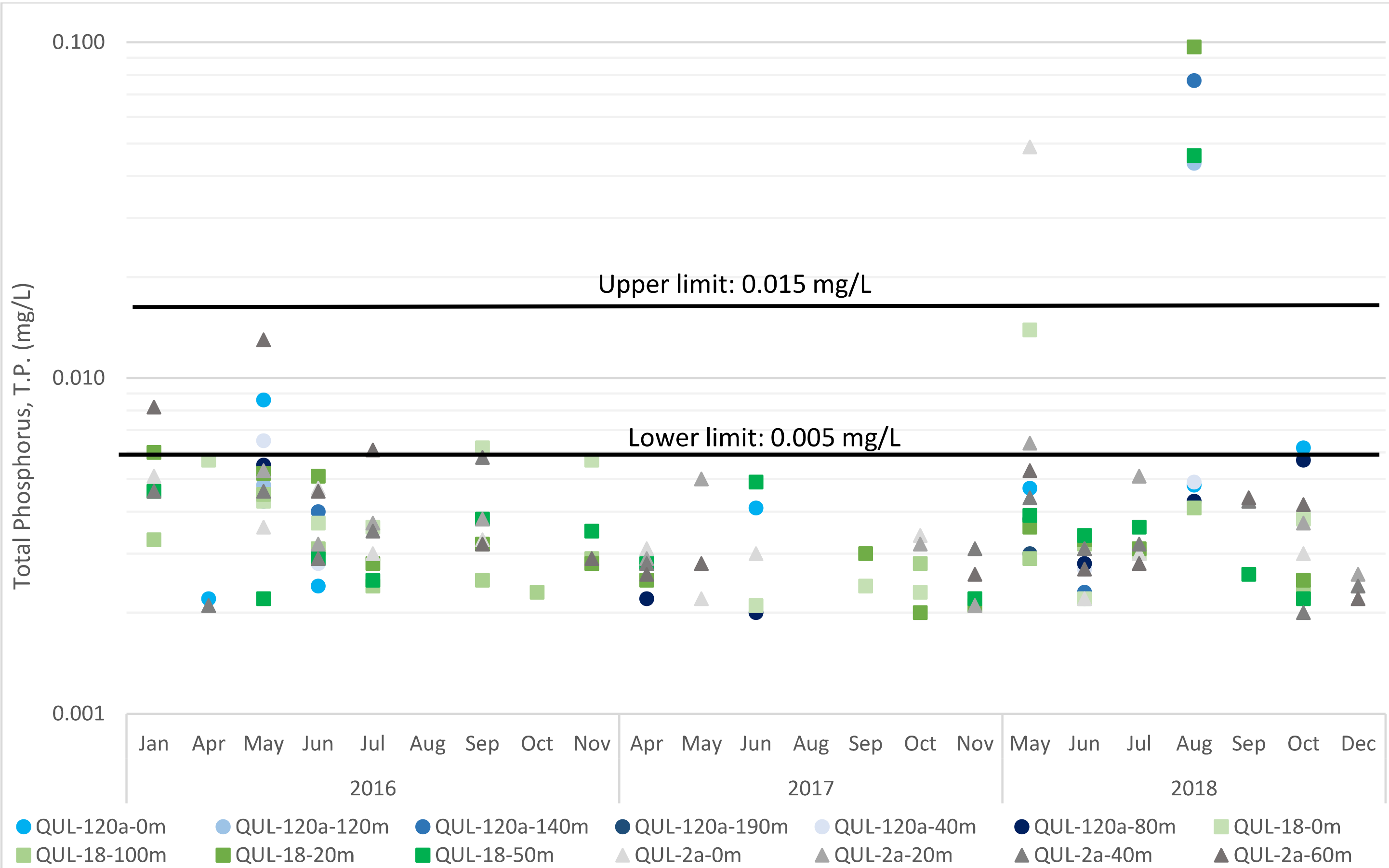

Figure 8.1 Total phosphorus concentrations at QUL-120a, QUL-2a, and QUL-18 from 2016 to 2018.

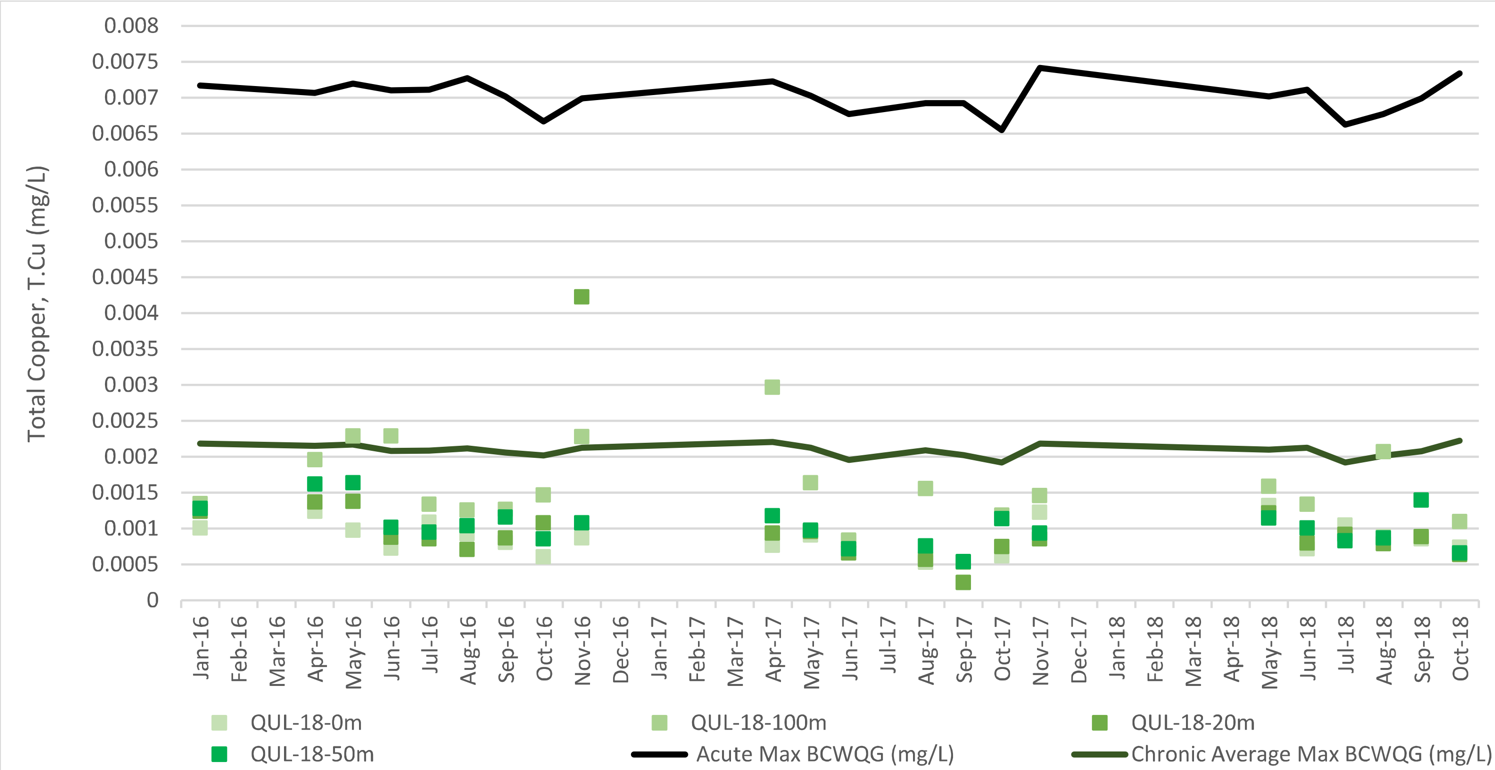

Figure 8.2 Total copper results at QUL-18 from 2016 to 2018

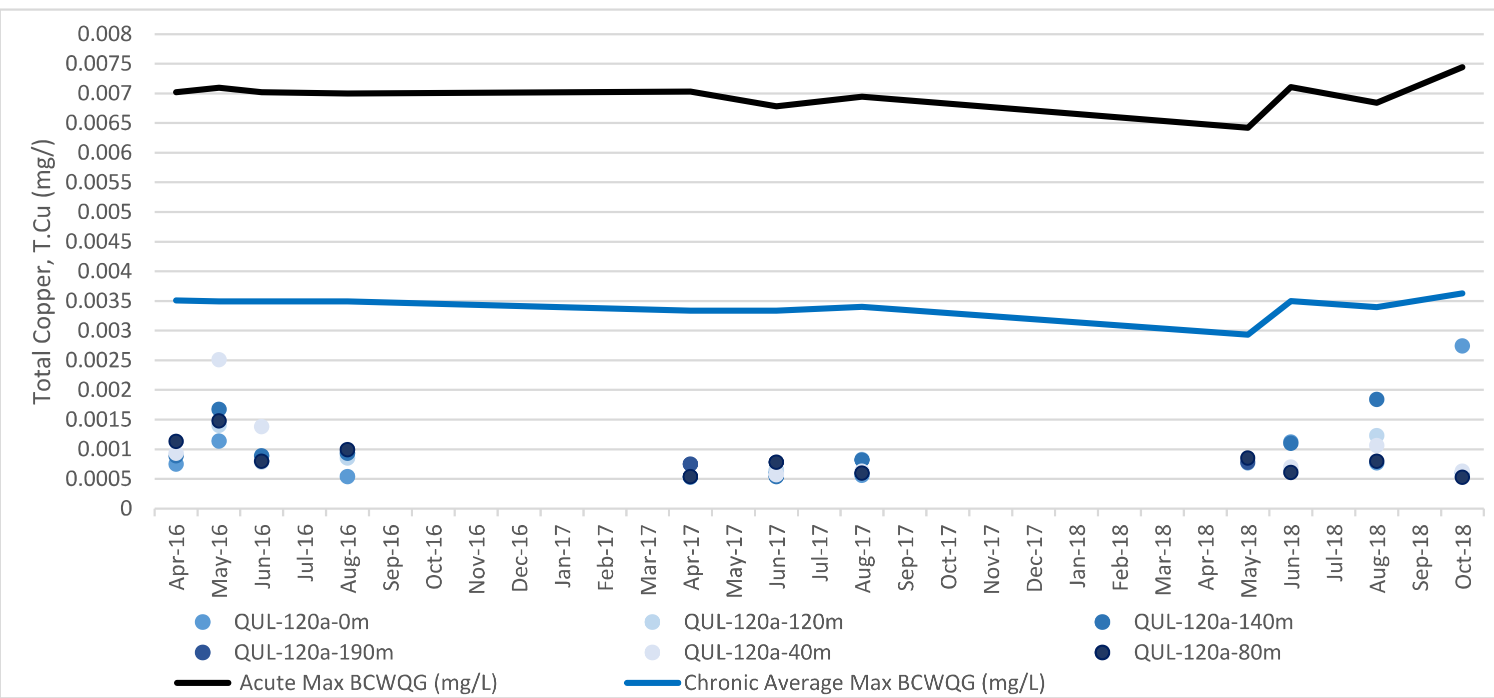

Figure 8.3 Total copper results at QUL-120a from 2016 to 2018

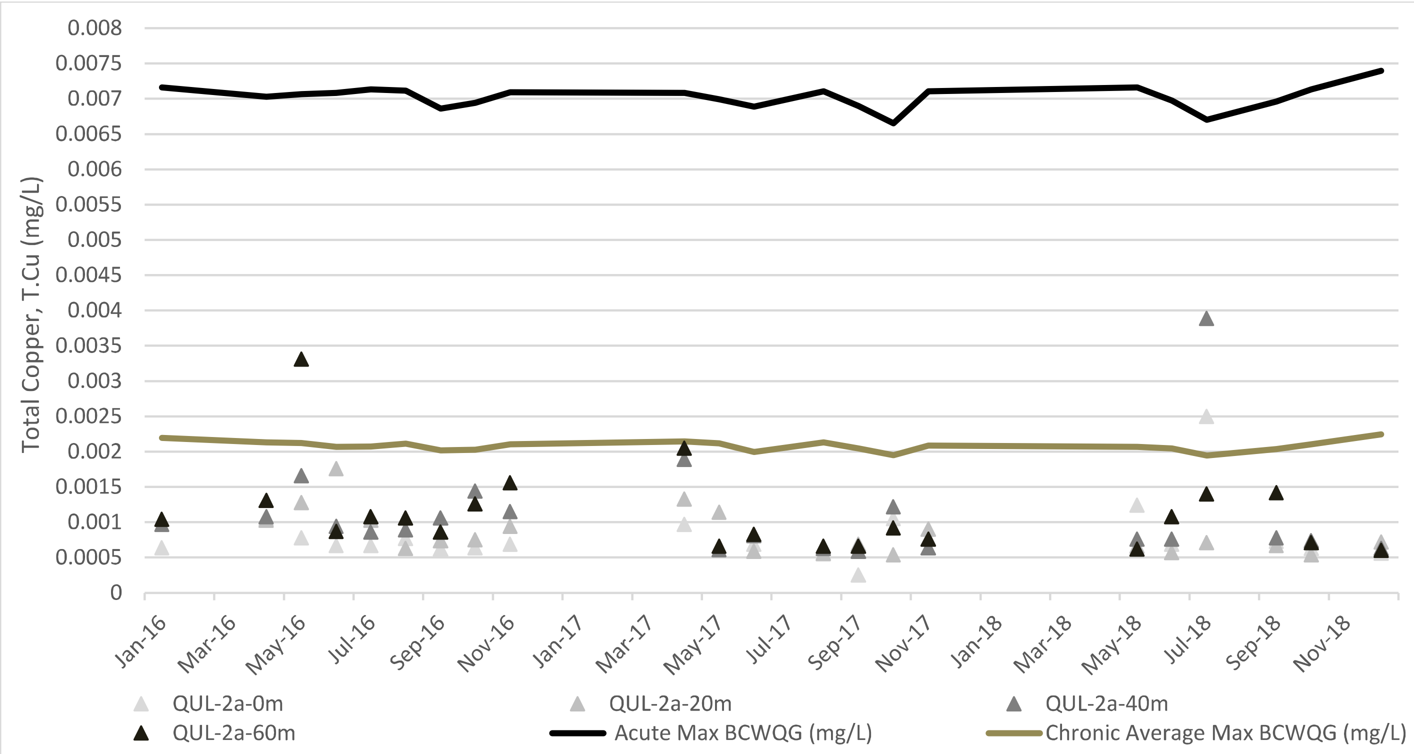

Figure 8.4 Total copper concentrations at QUL-2a from 2016 to 2018

8.3 Hydrology

In 2018, hydrological monitoring was completed at sites W1b (Morehead Creek), W4a (North Dump Creek), W5 (Bootjack Creek), W12 (6km Creek), and H3 (Edney Creek) as required by Section 3.4 of the *EMA* Permit 11678 and the *CEMP* (Appendix A). Supplemental monitoring was carried out at the SERDS, the NW Ditch, Junction Zone Ditch, Joe's Creek Pipe, and the East Main and South Toe Drains at the TSF. Refer to Appendix B for a map of monitoring locations.

Tables and figures presenting 2018 hydrology results at all sites, including hydrographs, rating curves, pressure transducer figures, and statistical analyses are presented in Appendix K – Site Hydrology. Recommendations from WaterSmith are included in Appendix K.

8.3.1 Site W1b – Upper Morehead Creek

Four (4) staff gauge readings and manual flow measurements were taken between May 28 and August 8, 2018. The highest manually measured discharge rate was 0.288 m^3/s on May 28, 2018.

In 2016, WaterSmith made significant changes to the site including removal of debris and installation of a new stilling well and staff gauge. No pressure transducer was installed at this site in 2018. A benchmark survey conducted on July 30 by WaterSmith indicated the staff gauge had been stable and the water level data did not require adjustment.

A stage-discharge rating curve was developed using the monitoring results from previous years and 2018 monitoring results. Data and the stage-discharge rating curve are provided in Appendix K – Site Hydrology. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean difference of 23% and a standard error of 15%. The stage-discharge rating curve may have experienced a shift due to staff gauge readings were consistently 2-3 cm below the rating curve in 2018; the reason for this is unclear, but mostly likely due to human error or possible channel scour leading to lower water levels.

8.3.2 Site W4a – North Dump Creek

At site W4a, thirteen (13) bucket flow measurements were recorded from a constructed pipe weir between March 22 and December 3, 2018. No staff gauge or pressure transducer was installed at this site in 2018. The highest estimated discharge rate was 0.0094 m^3/s on November 28, 2018. Flow data are included in Appendix K – Site Hydrology.

8.3.3 Site W5 – Bootjack Creek above Hazeltine Creek

Eleven (11) staff gauge readings and two (2) manual flow measurements were taken between May 15 and December 3, 2018. The highest manually measured discharge rate was 0.004 m^3/s on July 9, 2018.

A new stilling well and staff gauge were installed on April 13, 2016, approximately ten (10) meters downstream of the previous station. No pressure transducer was installed at this site in 2018. A benchmark survey conducted on July 30 by WaterSmith indicated the staff gauge had been stable and the water level data did not require adjustment.

A stage-discharge rating curve was developed using the monitoring results from previous years and 2018 monitoring results. Data and the stage-discharge rating curve is provided in Appendix K – Site Hydrology. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean difference of 11% and a standard error of 9%.

8.3.4 Site W12 – 6 km Creek at Bootjack Road

Seven (7) staff gauge readings and five (5) flow measurements were taken between May 9 and August 13, 2018. The highest manually measured discharge rate was 0.4 m^3/s on May 9, 2018.

In 2016, a new stilling well was installed by WaterSmith. No pressure transducer was installed at this site in 2018. A benchmark survey conducted on July 30 by WaterSmith indicated the staff gauge had been stable and the water level data did not require adjustment.

A stage-discharge rating curve was developed using the monitoring results from previous years and the 2018 monitoring results. Data and the stage-discharge rating curve are provided in Appendix K – Site Hydrology. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean difference of 20% and a standard error of 23%. As most of the flow measurements occurred at very low flows with the water level below their weir crest, the rating curve was not valid for staff gauge levels below 0.624 m; therefore, flow measurements from July and August were not included in the rating curve.

8.3.5 Site H3 – Lower Edney Creek

Five (5) staff gauge readings and manual flow measurements were taken between May 21 and July 31, 2018. The highest manually measured discharge rate was 0.370 m^3/s on May 21, 2018.

Pressure transducer data from a PT2x were recorded from April 20 to April 25, 2018. The PT2x was removed in November and it was discovered that the instrument had stopped recording data shortly after installation. The data accumulated was not useable. The instrument was sent to the manufacturer for repair and found that water had corroded the circuit boards and the cable had to be replaced. No hydrograph or stage-pressure relation could be established in 2018. Regular scheduled downloads of the pressure transducer to avoid data loss will be implemented in 2019.

A benchmark survey conducted on July 30 by WaterSmith indicated the staff gauge had been stable and the water level data did not require adjustment.

A stage-discharge rating curve was developed using the monitoring results from previous years and 2018 monitoring results. Data and the stage-discharge rating curve are provided in Appendix K – Site Hydrology. An assessment of the goodness of fit of the manual readings to the stage-discharge rating curve yielded a mean difference of 16% and a standard error of 9%.

8.3.6 Supplemental Sites

Flow monitoring and/or staff gauge measurements were also collected at supplemental sites including the SERDS, the NW Ditch, Junction Zone Ditch, Joe's Creek Pipe, and the East Main and South Toe Drains at the TSF. Results are presented in Appendix K – Supplemental Hydrology. These flow measurements from site water management system components are primarily used for verifying the site water balance.

8.4 Sediment Quality

Sediment quality samples were collected in Jacobie, Bootjack, Polley, and Quesnel Lake at various periods in 2018 by Minnow. Sediment toxicity samples were also collected in Bootjack, Polley, and Quesnel Lake. Samples were collected Bootjack, Polley, and Quesnel Lake using diffusive gradient in thin film technique (DGT) to study the sediment-water interface layer. These results are presented in the Minnow report provided in Appendix J.

8.5 Benthic Invertebrates

Benthic invertebrate community samples were collected in Bootjack, Polley, and Quesnel Lakes in 2018 by Minnow. These results are presented in the Minnow report provided in Appendix J.

8.6 Plankton, Chlorophyll *a*, and Secchi Disk

8.6.1 Plankton and Chlorophyll *a*

Chlorophyll *a* samples in Polley and Quesnel Lakes were generally collected two times (i.e. June and August) per growing season (Table 8.5). In 2016, chlorophyll *a* was collected three times at QUL-58, P1, and P2 for additional data. In 2017, an additional sample was collected at QUL-58; no samples were collected at QUL-ZOO-8 due to unsafe conditions from wildfires. In 2018, some chlorophyll *a* samples were collected in July and September as samples were missed at QUL-58 and QUL-2a in June, and QUL-ZOO-1, -7, and-8 and QUL-2a in August due to the proximity of forest fires limiting visibility and deteriorating air quality. An additional sample was collected at QUL-18 in May 2018. Chlorophyll *a* results from Polley Lake since 2011 are included in Figure 8.5 Chlorophyll *a* results from Polley LakeFigure 8.5. Chlorophyll *a* results from Quesnel Lake since 2014 are included in Figure 8.6.

Results from 2018 are in Appendix L and discussion for 2016 to 2018 results are in Minnow's report in Appendix J.

Table 8.5 Chlorophyll *a* sample events in 2016-2018

Site Name	2016 Sample Dates			2017 Sample Dates			2018 Sample Dates		
QUL-2a	28-Jun-16	15-Aug-16		19-Jun-17			25-Jul-18	05-Sep-18	
QUL-18	28-Jun-16	15-Aug-16		19-Jun-17			23-May-18	19-Jun-18	27-08-18
QUL-120a	27-Jun-16	24-Aug-16		31-Aug-17			19-Jun-18	27-Aug-18	
QUL-58	20-Jun-16	28-Jun-16	1-Aug-18	15-May-17	29-May-17	19-Jun-17	04-Sep-18		
QUL-ZOO-1	27-Jun-16	24-Aug-16		21-Jun-17	21-Aug-17		20-Jun-18	05-Sep-18	
QUL-ZOO-7	27-Jun-16	24-Aug-16		21-Jun-17	21-Aug-17		20-Jun-18	05-Sep-18	
QUL-ZOO-8	27-Jun-16	24-Aug-16					20-Jun-18	05-Sep-18	
P1	06-Jun-16	04-Jul-16	23-Aug-16	28-Jun-17	23-Aug-17		12-Jun-18	21-Aug-18	
P2	06-Jun-16	04-Jul-16	23-Aug-16	28-Jun-17	23-Aug-17		12-Jun-18	21-Aug-18	

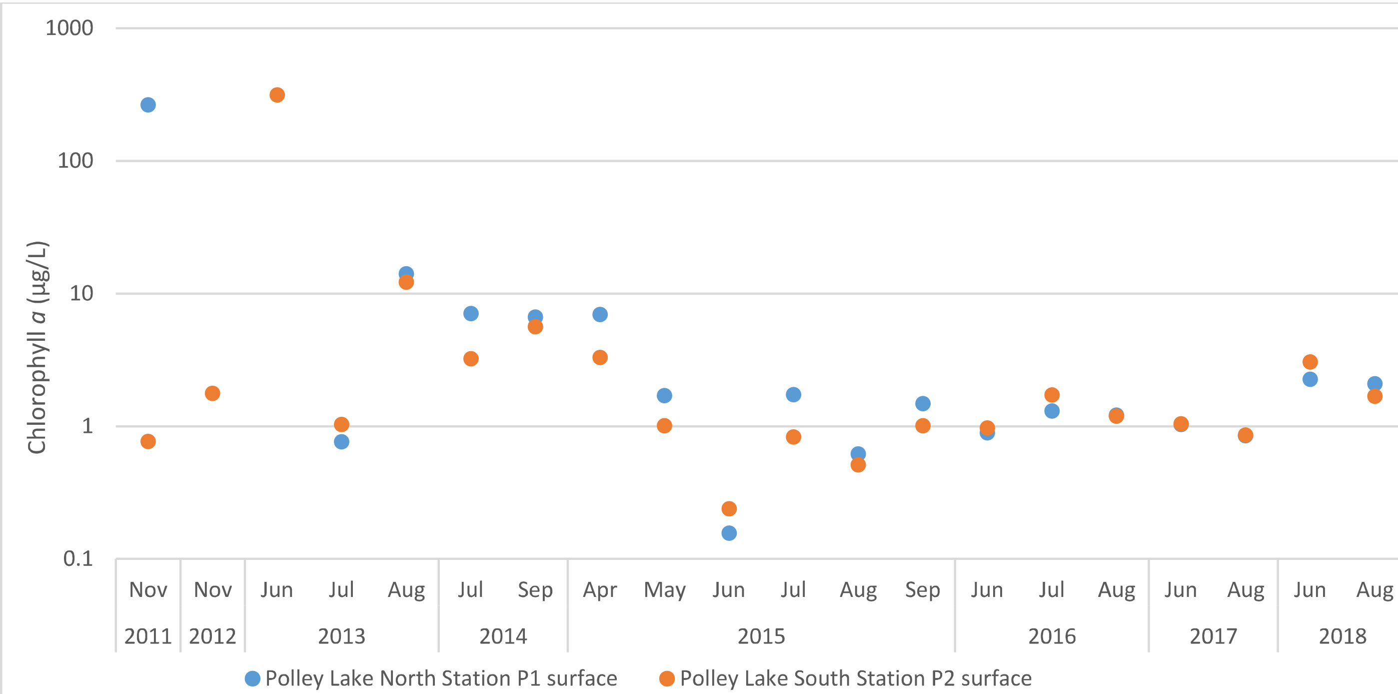

Figure 8.5 Chlorophyll *a* results from Polley Lake

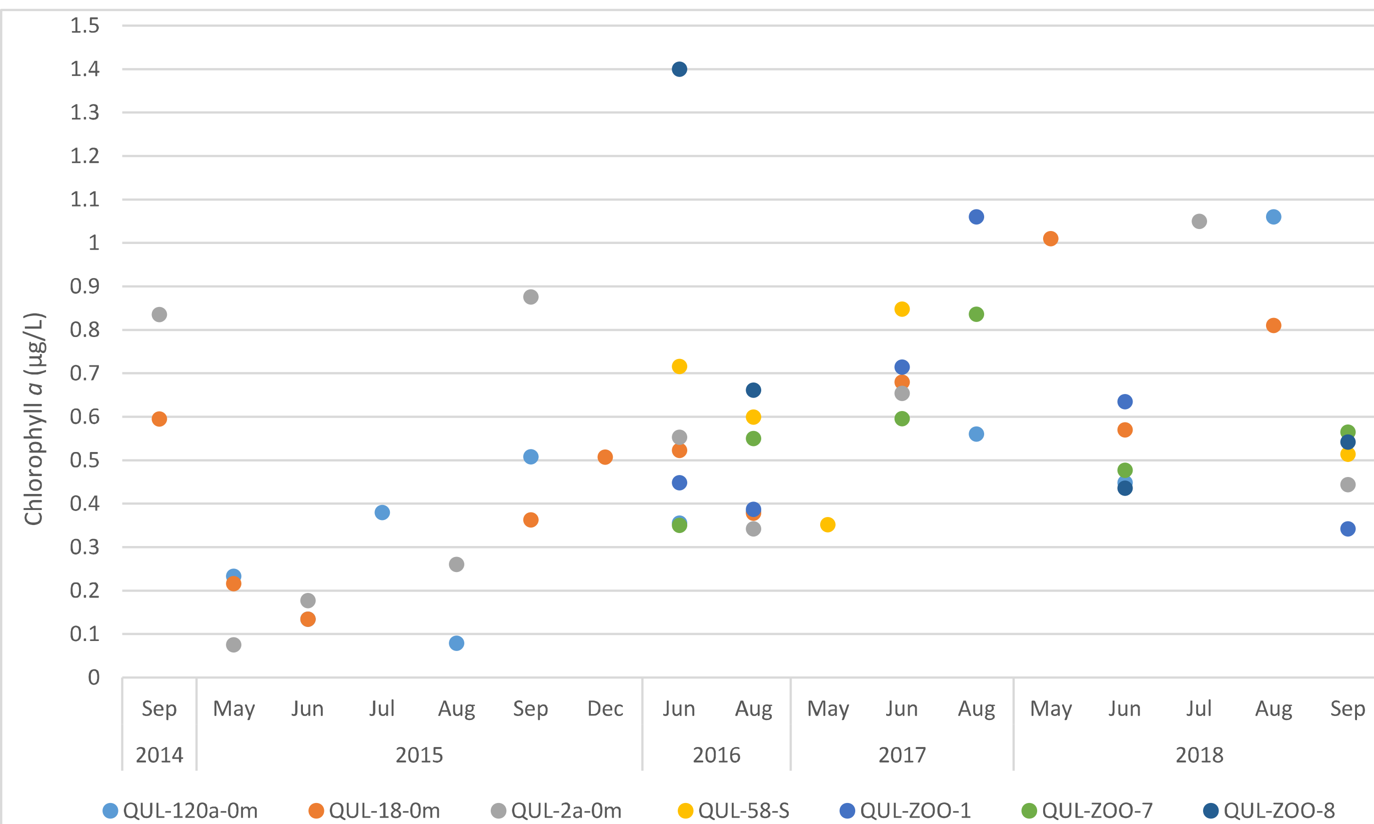

Figure 8.6 Chlorophyll *a* results from Quesnel Lake

Zooplankton and phytoplankton samples were also collected at surface depth, twice per growing season (June and August) at the same water quality monitoring stations in Polley Lake (P1 and P2). Samples were collected on June 12, and August 21, 2018. Quesnel Lake monitoring is conducted at three stations historically sampled by Department of Fisheries and Oceans (DFO), so pre- and post-TSF embankment breach results can be compared for both spatial and temporal trends. However, MPMC does not have access to the historic and current DFO data. Station 1 (QUL-ZOO-1) is located in the centre of the West Basin, station 7 (QUL-ZOO-7) is located in front of Horsefly Bay, and station 8 (QUL-ZOO-8) is located at the junction of the North, East, and West Arms (Appendix B). In 2018, phytoplankton, zooplankton community, and zooplankton metals samples were collected on June 20 and September 5, 2018 at QUL-ZOO-1, -7, and -8. Results are in Appendix L.

Additional review of phytoplankton, and zooplankton are presented in the Minnow's report in Appendix J. However, the Quesnel Lake zooplankton taxonomy is not included in the review as samples were still undergoing analysis during the compiling of the report. The raw Quesnel Lake zooplankton taxonomy are included in Appendix L.

8.6.2 Secchi Disk

During each sampling and profiling event, a Secchi depth measurement (Table 8.6) was collected (except if conditions were too windy/wavy) as per 2016 and 2018 *CEMP* (Appendix A). Secchi depth data are included in Appendix L.

Table 8.6 Secchi depth measurement events in 2018.

Site	Site Identifier (EMS No.)	Secchi Depth Measurement Events
P1	E207974	13
P2	E207975	14
B1	E207972	9
B2	E215897	11
B4	E216744	8
QUL-ZOO-1	E306455	2
QUL-ZOO-7	E306456	2
QUL-ZOO-8	E306457	2
QUL-120a	E303022	4
QUL-18	E303019	7
QUL-58	E304876	21
QUL-57	E304874	13
QUL-59	E304875	13
QUL-2a	E303020	6

All Secchi depths measured were within the range of measurements from previous years.

8.7 Fish

Several fish studies were conducted by Minnow in 2018. In Edney Creek, fish usage and habitat characterization studies and spawning surveys were completed. Fish tissue quality sampling was also conducted in Polley and Bootjack Lakes as well as Quesnel Lake and River. Ongoing fish community survey was completed in Polley Lake. Discussion of these results will be presented in the Minnow report provided in Appendix J.

9 Terrestrial Monitoring

Wildlife monitoring was the only terrestrial monitoring completed on the mine site in 2018. Additional terrestrial monitoring was completed along the Hazeltine Creek corridor and these details can be found in Section 7.9.

9.1 Wildlife Monitoring

The Mount Polley site and surrounding area is home to a wide variety of wildlife including ungulates, carnivores, raptors, water fowl, song birds, mustelids, amphibians and a host of aquatic organisms. With extensive wildlife activity on the mine site, MPMC provides training to all employees regarding management of food waste and bear awareness. This training and information is intended to help keep MPMC employees and the wildlife safe.

To meet requests by the ENV and various stakeholders, to provide valuable data for evaluating the effects of the mine on wildlife, and to monitor wildlife habitat creation through reclamation, the MPMC Environmental Department records wildlife observations and incidents on the mine site. In addition, MPMC maintains three motion triggered wildlife cameras which are staged in various locations on-site. The cameras collect photo-data from approximately April to November each year, and enable MPMC to capture around the clock wildlife activities. This information is considered valuable for future reclamation and land use planning.

Following the TSF embankment breach, MPMC submitted the *Post Event Environmental Impact Assessment Report* (PEEIAR) (MPMC, 2015a) that included an investigation of the impacts to wildlife. The findings stated that there was no evidence of direct impacts to local populations of larger mammals such as deer, moose or bear, but impacts due to bioavailability of metals was yet unknown. The *ERA* (MPMC, 2017c) evaluated the possible risks of metal bioaccumulation in various animals. The findings showed that metals were likely to have low bioavailability and a low risk of bioaccumulation. The *ERA* also compared the frequency of wildlife observations in 2015 to 2016, and noted that the observation of deer, small mammals and birds increased, likely due to increased forage ability. Ongoing remediation of the impacted areas are providing habitat and food for a variety of mammals and birds, which is an important step to rebuilding the ecosystems.

In 2016, there were 533, in 2017, 734, and in 2018, there were 399 recorded wildlife observations reported between June and December. The observation data from January to May 2018 were affected by the cyberattack discussed earlier. Observation numbers were also affected by the union strike as far fewer employees were on site. The observation include actual sightings, and observations of scat and tracks (Table 9.1). Observations included a wide range of different birds, carnivores, and several insects. It is assumed that the number of reported observations is only a fraction of the actual observations, but suggests regular use of the site by wildlife. Table 9.1 indicates some generic observations such as "Deer", these entries refer to sightings with no positive species identification.

In 2016 and 2017 there were no wildlife incidents reported. There was one wildlife incident reported in 2018. A young black bear was found dead below a power pole. The bear had likely climbed up the power pole and electrocuted itself. This incident was reported to the Conservation Officer Service and the bear was disposed of away from active work areas.

Table 9.1 2018 wildlife observations at Mount Polley Mine

2018 Wildlife Observations

Onsite		
Wildlife Observed	**# Observed**	**Scat/Tracks**
Black Bear	60	
Coyote	11	
Deer	11	
Ermine	1	
Great Horned Owl	1	
Grouse	14	
Hippogriff	1	
Lynx	11	
Moose	18	1
Mule Deer	20	
Sandhill Crane	4	
Skunk	1	

Offsite		
Wildlife Observed	**# Observed**	**Scat/Tracks**
Barred Owl	2	
Black Bear	3	
Bull Moose	1	
Cow Moose	1	
Coyote	2	
Grouse	7	
Lynx	7	
Swan	2	
Wolf	3	2

Breach Affected		
Wildlife Observed	**# Observed**	**Scat/Tracks**
American Dipper	1	
Bald Eagle	8	
Black Bear	3	
Canada Goose	6	
Deer	6	
Kingfisher	2	
Loon	1	
Mallard	1	
Moose	1	
Mountain Blue Bird	1	
Otter	5+	
Sandhill Crane	6	
Skunk	1	
Sockeye Salmon	11	
Swan	88	
Western Toad	80	

9.2 Archaeological Resources

First Nations with recognized claimed traditional territory for the Mount Polley Mine are the WLIB and the SCIB. Pre-mining studies noted that the area had low heritage resource potential due to the extensive disturbance in the area from logging and earlier mining projects (Points West Heritage Consulting, 1989).

There were no archaeological or historic sites identified at Mount Polley in 2018.

10 Reclamation Program

The objectives of the reclamation program are outlined in Section 1.1.1. To achieve these objectives, as outlined in the most recent *RCP* (MPMC, 2017a), MPMC has established projects at the site to research reclamation and closure methods, including soil amendments and application methods, re-vegetation, vegetation metal uptake, and passive/semi-passive water treatment. Based on the results of these research projects, larger scale progressive reclamation has been ongoing at Mount Polley since 2010, with two primary benefits:

1. Conducting reclamation during the operating life of the Mine reduces the size of disturbed area requiring reclamation at closure and minimizes liabilities.
2. Sites undergoing progressive reclamation can be continually monitored, and reclamation prescriptions modified based on findings. Using this approach, it is anticipated that a refined prescription for meeting reclamation objectives will be developed, and can be applied site-wide at Mine closure.

An update on 2018 progressive reclamation activities within the mine site and research projects is included in this section, as well as an updated five-year reclamation plan. Progressive Reclamation activities in 2018 included applying soil over 2.89 ha and planting trees over a 22 ha area. Progressive reclamation in 2018 does not include reclamation and revegetation activities associated with the breach. Further reclamation information can be found in the *RCP* (MPMC, 2017a) updated in January of 2017.

10.1 Reclamation Cost Update

No significant new disturbance occurred in 2018. One (1) minor area of new disturbance, the construction of an on-site CWTS (Section 10.5.2.2), occurred in September of 2018 and involved the disturbance of 1.05 hectares. A cost estimate for decommissioning this facility has not been completed. The cost for reclaiming the wetlands facility will be developed after the facility is fully commissioned. Currently, the facility is approximately 95% complete with completion scheduled for the 2nd Quarter of 2019.

10.2 Stability of Works

10.2.1 Rock Disposal Sites (RDS)

Examinations of RDSs are made in accordance with Section 6.10.1 of the *Health, Safety and Reclamation Code for Mines in British Columbia (HSRC),* (EMPR, 2017). Monitoring of RDSs occurs according to the terms and conditions of a variance granted by the EMPR on February 9, 2001. A report on the 2018 RDS inspection, prepared by a QP will be submitted to the EMPR by March 31, 2019.

10.2.2 Pit Walls

Pit walls are monitored for stability using high-precision 3-D surveys, radar monitoring, and surface inspections. Pit wall stability is reviewed annually by a third party QP from an engineering services firm. A report on the 2018 pit slope inspection, prepared by a QP and will be submitted to the EMPR by March 31, 2019.

10.2.3 Tailings Storage Facility and Associated Works

MPMC received authorization to proceed with construction activities at the TSF to a maximum elevation of 970 m under the *Mines Act* Permit M-200 June 23, 2016 amendment. Construction of the Main Embankment and Perimeter Embankment Buttresses for the 970 m approved design were deemed completed by the Engineer of Record (EoR) in 2016.

MPMC conducted the following TSF related construction activities in 2018:

- June – October, 2018 – Embankment construction from 966 m to 968 m at the Corner 1 breach in accordance with the TSF Detailed Design to 970 m.
- September – December, 2018 – Construction of the Corner 1 Buttress at the "Postage Stamp" for the 970 m stability, in accordance with the TSF Detailed Design to 970 m.
- Completion of the 970 m Corner 1 Buttress to occur in 2019
- September – December, 2018 – Sand cell construction to 968 m elevation in the upstream sand of the South Embankment and Perimeter Embankment

The following inspections occurred at the TSF in 2018:

- Annual Dam Safety Inspection (ADSI), conducted by the EoR in October 2018 as required by Section 4.2 of the *HSRC* (EMPR, 2017).

In addition to the physical activities, MPMC also submitted the following reports:

- Geotechnical investigation along Corner 1 using sonic drilling and laboratory tests was completed in January 2018 under the supervision of the EoR, as required under the June 23, 2016 *Permit M-200* amendment.
- Stability analysis conducted on Corner 1 embankment to bring elevation from 950 to 970 results from the 2018 Geotechnical Investigation
- An as-built report for the 2018 construction period was prepared by the EoR and will be submitted to the EMPR by March 31, 2019.
- The 2018 ADSI report, as required under the *HSRC* (EMPR, 2017) to be submitted to EMPR by March 31, 2019

There were no unusual or dam safety related occurrences in 2018. Pond water volume fluctuated between 1.5M and 4.0M m^3, with excess water available for discharge through the WTP.

10.3 2018 Reclamation Activities

10.3.1 Reclamation Inspection

On June 13, 2018, EMPR conducted a site visit to review changes in site conditions since the last inspection and to carry out a *Mines Act* environmental and reclamation compliance inspection. An inspection report was issued including recommendations related to Permit M-200 the *HSRC* (EMPR, 2017) and established best practices in environmental management and Mine reclamation.

The report included four (4) advisories and two (2) information requests that required responses from the Mine manager. All advisories and information requests have been considered, and a summary is provided in Table 10.1.

Table 10.1 Summary of EMPR reclamation inspection recommendations

EMPR Inspection Report June 13, 2018	
Advisory	**MPMC Response**
1. Stockpiled waste tailings material salvaged from the Polley Flats/tailings breach area was observed near the biosolids stockpile area. There was discussion by Mine staff that this material may be suitable for reclamation as a soil material or to augment other soil sources. The cover trials being designed by a consultant will likely incorporate these materials. It is advised that before this material is used for reclamation that it be adequately characterized for potential contaminants of concern and to determine options to improve suitability for use in reclamation.	*Golder Associates will be constructing and monitoring multiple test plots beginning this summer for the purpose of evaluating low-flux soil covers using different soil media. Although the Golder testing is focused on evaluating cover soils in terms of infiltration and water balance, monitoring of the soil covers will also include the effectiveness of different covers as growth media. Golder has already characterized different materials from around the Mine site (September, 2017) including the tailings near the biosolids area Two Golder Technical Memos describing the work that was done in September of last year and what will be done this summer are attached with this inspection response.*
2. The stockpiled tailings consisted of fine textured material prone to wind and water erosion. It is advised that this material be protected by vegetating with suitable plant species for erosion control purposes or other effective means. The area should be inspected to determine if contouring is also required to ensure that materials aren't exposed to standing or uncontrolled water sources.	*MPMC will commit to seeding this stockpile and adding any erosion control BMPs deemed necessary. Erosion control and any contouring will be completed as soon as possible. Seeding may not occur until the fall MPMC does have a Fugitive Dust Management Plan that it adheres to which mitigate dust problems.*

3. The biosolids stockpile area consisted of a cover of invasive plant species. Similar species were also observed in the biosolids reclamation trials on the North Bell Dump. It is advised that prior to the movement and use of biosolids material, mitigation and management measures be developed to prevent the transport and spread of weed species to reclamation areas.	*At this point in time, it is unclear whether biosolids will be used as a soil amendment for revegetation; however, should it be decided that Golder or MPMC will utilize the material, MPMC will develop a plan for handling and transporting the biosolids in order to prevent the spread of invasive plants.*
4. It is understood that an alternative sprinkler system is being considered and the area of exposed tailings will be larger in size than observed at the time of inspection. EMPR has received a Fugitive Dust Management Plan in the response to the October 2017 inspection. EMPR will review the plan and provide comment in comparison with the ENV-EMPR guidance document on "Developing a Fugitive Dust Management Plan for Industrial Projects." A copy of the guidance document will be provided to the Mine for reference.	*So noted and thank you.*

Information Requests	**Response**
1. A number of reclamation trails have been established to investigate species selection, soil amendment application and site prep. It is not clear the basis of the monitoring programs that have been implemented is. MPMC is requested to develop a formalized monitoring program to assess the effectiveness of the reclamation prescriptions that have been applied (and that will be applied in the future) in comparison with the land capability (ecosystems/site series) and land use (wildlife habitat and forestry) targets for the property. As part of the response to this report, please provide a timeframe for the development of this key monitoring program.	*MPMC will develop a comprehensive monitoring program to assess and evaluate soil and vegetation prescriptions. A viable monitoring program that is used to determine the "success" of revegetation efforts is a critical component to all reclamation projects. Establishing what is successful in terms of quantitative and qualitative criteria and following established guidance for measuring vegetation success, is essential. The draft RCP or Reclamation and Closure Plan (January, 2017) refers to guidance, protocols, and systematic programs designed to assess and evaluate overall reclamation and revegetation progress and ultimately success (e.g. BC Geoclimatic Ecosystem Classification System and the End Land Use Plan). Based on continued testing and future studies, MPMC anticipates adding detail to the existing monitoring plan that is part of the RCP. Amending the overall site-wide post closure monitoring plan will be accomplished over time.*

2. Mount Polley is proposing to design a cover trial program in the near future. EMPR requests a copy of the cover trial study design for review once it is complete. As part of the response to this report, please provide a timeframe for the development of the cover trial design and implementation workplan.	*Attached with this submittal, are two Technical Memos developed by Golder that describe the test plot work. Work will commence on the test plots in July, 2018.*

10.3.2 Progressive Reclamation

Further information on progressive reclamation at Mount Polley Mine is summarized in the following sections. Table 10.2 details the progressive reclamation completed up to date and summarizes the area disturbed and reclaimed in 2018, and fulfills the EMPR requirements for Table 1.

Table 10.2 Progressive reclamation completed at Mount Polley Mine as of December 31, 2018

Area	Parcel	Re-contoured (ha)		Soil/Till Applied (ha)		Seeded (ha)		Fertilizer/Biosolids (ha)		Tree-Planted (ha)	
		2018	Total	2018	Total	2018	Total	2018	Total	2018	Total
NEZ Dump	2a, 2b1, 2b2	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13
	Beside 2a/2b	0.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NBD	Parcels 1 - 10	0.00	9.45	0.00	11.59	0.00	11.59	0.00	11.59	0.00	11.59
	South Triangle	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30
	Phase 1	0.00	2.21	0.00	2.21	0.00	2.21	0.00	2.21	2.21	2.21
	Phase 2	0.00	2.87	0.00	2.87	0.00	2.87	0.00	2.87	2.87	2.87
	Metro Van Research 1	0.00	2.81	0.00	2.81	0.00	1.87	0.00	2.34	0.00	2.34
	Wrap Around Toe	0.00	0.00	0.00	2.20	0.00	2.20	0.00	0.00	0.00	0.00
	Beside Research 1	0.00	4.76	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00
	Metro Van Research 2	0.00	2.00	0.00	2.00	0.00	1.33	0.00	1.66	0.00	2.00
	Beside Research 2	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Beside BJ FSR	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boundary Zone	Dump	0.00	4.70	0.00	4.70	0.00	0.00	0.00	0.00	4.70	4.70
East RDS	Above Access Road	0.00	3.42	0.00	4.06	0.00	4.06	0.00	0.00	2.75	2.75
	Highway to Heaven	0.00	11.53	2.89	9.47	0.00	6.58	0.00	0.00	9.47	9.47
	Tree Plots	0.00	2.31	0.00	2.31	0.00	2.31	0.00	1.20	0.00	2.31
Waste Haul Road	Above WHR	0.00	1.81	0.00	1.81	0.00	1.81	0.00	0.00	0.00	0.00
	Below Helipad	0.00	1.53	0.00	1.53	0.00	1.53	0.00	1.53	0.00	1.53
South Till Borrow		0.00	23.25	0.00	0.00	0.00	14.75	0.00	12.00	0.00	0.00
	TOTAL	0.00	85.18	2.89	55.98	0.00	59.54	0.00	41.83	22.00	48.20

10.3.2.1 Waste Dumps: North Bell Dump

Trees were planted on approximately 5.08 ha was completed on the North Bell Dump in 2018. Monitoring of past reclamation is ongoing.

10.3.2.2 Waste Dumps: NEZ Dump

No new reclamation work was completed on the North East Zone Dump in 2018. Monitoring of past reclamation is ongoing.

10.3.2.3 Waste Dumps: Boundary Dump

Trees were planted on approximately 4.70 ha on the Boundary Dump in 2018. Monitoring of past reclamation is ongoing.

10.3.2.4 Waste Dumps: East RDS

Trees were planted on approximately 12.22 ha and soil was applied on approximately 2.89 ha on the East RDS in 2018. Monitoring of past reclamation is ongoing.

10.3.2.5 Watercourse Reclamation

No watercourse reclamation was conducted in 2018.

10.3.2.6 Pit Reclamation

No pit reclamation was conducted in 2018. The Bell Pit, Pond Zone Pit, and Southeast Zone (SEZ) Pit have been back-filled by waste dumps and will not require reclamation.

10.3.2.7 TSF Reclamation

No reclamation was conducted at the TSF in 2018.

10.3.2.8 Road Reclamation

No road reclamation was conducted in 2018.

10.3.2.9 Treatment of Structures and Equipment

No site structures or equipment were salvaged or disposed of in 2017.

10.3.2.10 Securing of Mine Openings

There was no sealing or securing of any Mine entrances in 2018; both portal and escape ways were open and usable.

10.3.3 Re-vegetation

MPMC recognizes re-vegetation as a critical aspect of site maintenance and reclamation. Disturbed areas are grass seeded on an ongoing basis to prevent erosion and invasive species establishment. Soil stockpiles and areas that are unlikely to be disturbed are typically prescribed a native seed mix (Table 10.3). Sites that may be re-disturbed (or where preventing establishment of native species is the primary goal) are typically prescribed an aggressive seed mix (Table 10.3). This mixture grows rapidly in the short term, but dies off allowing the ingress of native species from surrounding areas.

All non-active soil stockpiles on site are regularly inspected for erosion and vegetative cover and any non-active stockpiles requiring additional vegetative cover and/or showing signs of erosion are added to the bi- annual (spring and fall) seeding list. This seeding list serves to track areas that require seeding, their size, description and type of seed.

Ground cover seeding took place in 2018 around the newly built CWTS and Northeast Zone Sump and associated pipeline. MPMC maintains an active Seeding List that serves to track areas that require seeding, their size, description and type of seed.

In addition to seeding ground cover (herbaceous) vegetation, the primary re-vegetation objectives at the Mine include the establishment of woody shrubs and trees (coniferous and deciduous). MPMC recognizes the importance of appropriate seed source and selection for long-term success and endeavors to use local seed sources. All of the conifer management at the Mine is consistent with provincial forest management practices as governed by the *Forest and Range Practices Act* (ENV, 2002). This includes participation in regional silviculture strategies, stocking standards, tree species selection, and seed planning and registration. Additional erosion control is provided through re-vegetation associated with site progressive reclamation described in Section 10.3.2.

Table 10.3 Aggressive and native seed mixes for reclamation

Species	% by Weight
Aggressive Seed Mix	
Dahurian Wildrye	25
Slender Wheatgrass	30
Perennial Ryegrass	15
Timothy	5
Native Seed Mix	
Mountain Brome	25
Native Red Fescue	10
Rocky Mountain Fescue	14.31
Bluebunch Wheatgrass	25
Blue Wildrye	25
Fireweed	0.014
Big Leaf Lupine	0.68

10.4 Invasive Plant Management

Invasive plant species are managed under MPMC *Invasive Plant Management Plan*. This plan was reviewed in 2018 (as required by *Mines Act* Permit M-200) and was included in the 2017 *AERR* (MPMC, 2018a). Invasive species management activities in 2018 included:

- Seeding of soil stockpiles that are not active and new disturbed areas (Section 10.3.3) as well as new reclamation sites (unless they are covered with freshly stripped soil that is expected to re-vegetate without seeding) to promote establishment of native species.
- Use of only high-quality grade seed, currently sourced from Premier Pacific Seed (Table 10.3). At a minimum, seed used is of the grade Common No.1 Forage Mixture (or better) or Canada No. 1 Ground Cover Mixture. All seed used meets or exceeds Canadian Food Inspection Agency (CFIA) and regional standards for presence of noxious weeds.
- Monitoring of soil stockpiles to evaluate presence of invasive species (Sections 10.4; 11.4.2).
- Planting of trees and shrubs in reclamation areas deemed inactive for mining purposes in a timely fashion to encourage rapid canopy closure (Section 10.3.2).
- Completion of invasive plant control program based on the 2017 assessment by Spectrum Resource Group Inc. (Spectrum).

The invasive species currently known to be present at Mount Polley Mine that are listed in the *2018 Regional Strategic Plan for Invasive Plant Management* and *Executive Summary* by the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC, 2018) are oxeye daisy, Canada thistle, orange hawkweed, yellow hawkweeds (non-native), and scentless chamomile. All of these plants have the priority ranking "3 – Established", and are common and widespread, with widespread control not currently possible. As such, MPMC's approach is to manage invasive species at this site such that they do not inhibit reclamation activities, with recognition that all outside sources (for example, cattle, wildlife, wind and water) pose challenges to eradicating invasive plants at the Mine site that are widespread in the surrounding areas.

In 2017, MPMC contracted Spectrum, a vegetation management solution provider to conduct an invasive plant inventory for Mount Polley Mine, including the Hazeltine Creek corridor. In 2018, the species management recommendations from that inventory were carried out, also by Spectrum. Targeted species included Canada thistle, Oxeye daisy, Orange hawkweed and Scentless chamomile. This work included selective application of herbicides by qualified professionals.

10.5 2018 Reclamation and Closure Research Update

Limited reclamation research was conducted in 2018. Ground cover data were collected for a small component of ongoing biosolids reclamation research on the North Bell Dump. These additional data were presented in *Biosolids and Conifers: Friends or Foes? Competition between Herbaceous Vegetation and Conifer Seedlings on a Biosolids Amended Rock Disposal Site at Mount Polley Mine* (Hunt et al, 2018) at the BC TRCR Symposium.

Information on ongoing and past reclamation research can be found in MPMC *AERR*s from 2010 to 2017. Further information can be found in MPMC *RCP* Update January 2017 (MPMC, 2017a).

10.5.1 Biosolids

In 1999, the ENV issued MPMC a permit to import biosolids from the Greater Vancouver Regional District (now Metro Vancouver) for the purpose of mine site reclamation (*EMA* Permit 15968). After initial receipt and stockpiling of the biosolids shipments in 2000, the program was suspended due to the temporary closure of the Mine; biosolids shipment recommenced in 2007. In 2014, *EMA* Permit 15968 was amended to include:

- An increase in the maximum rate of land application from 150 dry tonnes (dt)/ha to 165 dt/ha;
- An increase in the maximum cumulative discharge from 90,000 dt to 99,000 dt;
- Revised references to MPMC land claims and an updated site plan; and
- The allowance of two designated storage facilities.

Currently there is only one (1) biosolids stockpile on site, located near the TSF. Table 10.4 provided by Metro Vancouver, summarizes biosolids deliveries and applications at Mount Polley from 2000 to 2014. No biosolids were used on site in 2018 and no changes to stockpiiled volumes have been mae since 2014. As no deliveries were made in 2018, no Metro Vancouver biosolids were assessed for compliance with *EMA* Permit 15968 requirements or compared to the Organic Matter Recycling Regulation criteria for Class A biosolids.

Table 10.4 Metro Vancouver biosolids deliveries and applications at Mount Polley (2000 – Present)

Mt Polley Inventory, Updated: Mar. 7, 2018							
Stockpile Location	Delivery Date			Biosolids Delivered: Annacis	Lulu	Total (wt)	Total (*dt*)
Tailings Storage Facility Stockpile (Area 1)	2000/01 inventory				10,754	10,754	*2581*
	Feb 7 - Nov 2, 2007				4,641	4,641	*1114*
	Aug 5 - Nov 1, 2009			7,101	124	7,225	*2160*
	Jan 1 - Nov. 12, 2010			16,136	42	16,178	*4367*
	Apr 4 - 14; July 4, 2011			1,206		1,206	*338*
	Apr 25 - Sept. 4, 2013			9,664		9,664	*2706*
NEZ	Sep 28 - Nov 19, 2008			3,875		3,875	*1163*
	Apr 15 - May 29, 2011			5,058		5,058	*1416*
North Bell	2012 deliveries: MPMC "Area 2" (May 30 - June 17)			1,060		1,060	*297*
	2012 deliveries: MPMC "Area 1" (June 18 - July 31)			1,482		1,482	*415*
	2013 Deliveries: Tree Trial Plots (Sept. 28 - Oct. 6)			960		960	*269*
	2014 Deliveries : Tree Trial Plots (May 21 - 27)			706		706	*198*
	Delivered 2000-to-present			**47,247**	**15,561**	**62,808**	***17022***
Applications	**Site ID**	**ha**	**rate (dt/ha)**	Biosolids Utilized: Annacis	Lulu	Total (wt)	Total (*dt*)
	tree research plots (circa 2000/01)				234	234	*56*
	NEZ - **2008**			3,875		3,875	*1,163*
	North Bell Roadside Slopes (Areas 1 - 10) - **2011**	11.6	122	5,058		5,058	*1,416*
	North Bell (Areas 11 - 19) - **2012**	5.1	140	2,542		2,542	*712*
	North Bell Tree Trial Plots (Plots 2-6) - **2013**	2.3	104	960		960	*269*
	North Bell Tree Trial Plots (Plots 8-12) - **2014**	1.7	118	706		706	*198*
						-	
	CONFIRMED - APPLIED/USED to date			**13,141**	**234**	**13,375**	***3,813***
	Carry Over (at TSF)			**34,106**	**15,327**	**49,433**	***13,209***

10.5.2 Passive Treatment

The Anaerobic Biological Reactor (ABR) was a pilot passive water treatment system constructed at the Mount Polley site in 2009 in partnership with the University of British Columbia and Genome BC. In 2015, the ABR was decommissioned in preparation for buttressing of the TSF Main Embankment. The objective of the ABR was to reduce elevated parameters in Mine effluent through microbial activity to concentrations appropriate for discharge into the receiving environment.

Monitoring results (refer to pervious *AERR*s) indicate that the ABR was capable of reducing metal concentrations in

TSF toe drain water to below BC WQGs for protection of aquatic life for all parameters except sulphate. Research indicated the primary causes for the low levels of sulphate reduction to be a lack of dissolved metals for sulphate to bind to and insufficiently anaerobic conditions during summer months.

In 2016, MPMC engaged Contango Strategies Ltd. (Contango) and Golder, to initiate further research work into the feasibility of passive and semi-passive water treatment at the Mount Polley Mine site. As stated in the *RCP* 2017 Update (MPMC, 2017a), "a passive or semi-passive system is the preferred option for water treatment during closure/post-closure; however, optimization through bench- and pilot-scale testing is required to address uncertainties and to optimize the design of a full-scale system" or systems. Where technically achievable, the Mine intends to initiate passive and/or semi-passive treatment during operations.

The work initiated in 2016 identified and characterized the feed water chemistry and flows of various locations on site that would be most suitable for passive treatment and identified sites that could be (a) discharged directly with little or no treatment, (b) suitable pilot sites for simple passive treatment systems, and (c) potential pilot sites for semi-passive treatment. Individual flows for various Mine water sources were individually assessed in order to tailor treatment technologies to specific sources and their characteristic chemistry. Also, wherever possible, passive treatment systems (if shown to be feasible) are to be designed to make use of materials available on site or from the local area (MPMC, 2017a).

Currently passive treatment research is being advanced in parallel across multiple fronts. Key passive treatment initiatives being investigated include use of biochemical reactors (BCR), CWTS, and in situ pit lake treatment. Summaries of the work completed to date and future plans are provided below, with further detail provided in the Treatment Works and Source Control Optimization: Progress Report #2 Golder, 2018a) and #3 (Golder, 2018b) submitted to ENV under Section 2.9 of *EMA* Permit 11678.

10.5.2.1 BCRs

Work is ongoing with Golder to explore the potential for use of BCRs at the Mount Polley site. This work complements the previous ABR research, and includes evaluation of a potential passive treatment 'train' configuration (and the role of a BCR within it). As summarized in the *LTWMP TAR* (Golder, 2016b) and *RCP* (MPMC, 2017a) work conducted in completing the site selection screening, contaminants of potential concern (COPC) identification and technology assessment and preliminary implementation scheduling supports advancing the concept of BCRs to the bench-scale phase. Work in 2018 included bench-scale testing of various combinations of BCR substrate, inoculums and influent water. Results of the bench-scale testing will inform the advancement to, and subsequent design off pilot-scale works.

10.5.2.2 CWTSs

Work is ongoing with Contango to explore the potential for use of CWTSs at the Mount Polley site. Following initial site visits in 2016 and initial review of the information contained in the *RCP* 2017 Update, Contango completed a *CWTS Feasibility Assessment Report* (Contango, 2017). Findings of the assessment determined, among other things, that the water chemistry at the Mount Polley site is relatively benign and that passive treatment is conceptually and theoretically possible.

Contango proposed a 5 phase approach to assessing the feasibility of passive water treatment through the use of CWTSs. Part of Phase 1 included design work for the construction of CWTS's both on-site at Mount Polley and off-site at Contango's research facility in Saskatchewan. Phase 2 tested, through bench-scale testing, different substrates to be used in the CWTS as well as testing the treatability of Mine site water. Phases 2 and 3 were initiated in 2018 including the off-site CWTS which was constructed and commissioned in September 2018 and the on-site CWTS with construction also beginning in September, 2018 and continuing until freeze-up in late November. The on-site CWTS is approximately 95% complete and will be commissioned in the spring of 2019.

10.5.2.3 In situ Pit Lake Treatment

Work is ongoing with Golder to explore the potential for use of in situ pit lake treatment at the Mount Polley site. Informed by the results of the water quality modelling included in the *LTWMP TAR* (Golder, 2016b), the primary target of the in situ pit treatment investigation is selenium reduction. This treatment technology relies on the same anaerobic microbial reduction process as some active and passive biological treatment, and involves amending surface water to promote this anaerobic reduction.

A desktop study conducted in 2017 (MPMC, 2017a) supported the feasibility of the treatment methodology, and recommended advancing to bench-scale testing. Work in 2018 included bench-scale testing of various combinations of carbon amendments, inoculums and influent water. Results of the bench-scale testing will inform the advancement to, and subsequent design off pilot-scale works.

Next steps will involve development of a Golder Workplan for the development of passive and semi-passive water treatment systems including BCR and pit lake in situ treatment. Work is ongoing with optimization of the WTP as described in Section 6.1.1 as well as continued evaluation of the off-site wetlands system with the off-site CWTS scheduled to come on-line in the spring of 2019. As alluded to, the objectives of these studies potentially include, but are not limited to, further investigation of site characteristics, bench-scale testing, followed by pilot-scale testing of passive and semi-passive treatment at various locations on the Mine site to confirm the feasibility of proposed treatment approaches.

10.5.2.4 Geomorphic Slope Guidance

A Geomorphic Slope Guidance (Golder, 2017b) document was developed to provide guidelines for site slope recontouring and stream rehabilitation at and around the Mount Polley Mine and will also provide guidance for engineering works that would result in a natural looking slope upon closure. This guidance document will aid in long-term water management.

10.5.2.5 Soil Cover Test Plot Design

The Soil Cover Test Plot (Golder, 2018c) work, when completed may provide guidance to determine a reclamation cover soil design that reduces infiltration of water into and mass loading of constituents from waste rock disposal sites. This work may also become part of long-term water management.

10.6 Five Year Reclamation Plan

Table 10.5 outlines Mount Polley's previous five (5) year progressive reclamation plan. This table has been updated to summarize reclamation prescriptions to date. MPMC currently has no plans for Mine site reclamation for the next five years and as such no projected five year reclamation summary is included in this report. It should be noted that several areas have been identified as candidates for progressive reclamation but there are no immediate plans for completing the work. Work in the next five years will focus on monitoring of progressive reclamation and research projects.

Table 10.5 Previous five (5) year progressive reclamation plan

Site Specifications				Soil				Revegetation			Schedule						
Site	**Parcel(s)**	**Area**	**End Land Use Objectives**	**Soil Stockpile Source**	**Volume (m^3)**	**Application Depth (cm)**	**Ammendments**	**Grass Seed Mix[1]**	**Shrub & Deciduous Tree Planting**	**Conifer Tree Planting**	**Re-Contour**	**Soil Application**	**Soil Ammendment Application**	**Coarse Woody Debris Applicaiton**	**Grass Seeding**	**Shrub & Deciduous Tree Planting**	**Conifer Planting**
North Bell Dump	Parcels 1-10	11.59	Wildlife, forestry	Wight Till	10,600	20	Biosolids (122 dt/ha)	Native grasses (30 kg/ha) (hydroseeded with fibre mulch, except southern-most Parcel 10 hand seeded at 35 kg/ha)	Black cottonwood - 60 sph Paper birch - 34 sph Trembling aspen - 34 sph Sitka alder - 172 sph Saskatoon - 34 sph Prickly rose - 34 sph Scoulers willow - 79 sph Soopolalie - 100 stem trial plot	Lodgepole pine - 1075 sph Douglas fir - 451 sph Western red cedar - 54 sph Hybrid spruce - 54 sph Consider underplanting with later successional species in future.	2011	2011	2011	2011	2011	2013 - poor survival 2014 - re-plant	2014
	South Triangle	1.30	Wildlife, forestry	North Bell Dump Till	1,733	30	18-19-18 Fertilizer (75 kg/ha)	Native grasses (35 kg/ha) (hydroseeded with fibre mulch)	2013 Black cottonwood - 1000 sph Sitka alder - 800 sph 2014 Soopolalie - 100 stem trial plot	Lodgepole pine - 1400 sph Douglas fir - 600 sph Consider underplanting with later successional species in future.	2011	2011	2011	-	2011/2012	2013/2014	2014
	Phase 1	2.21	Wildlife, forestry	North Bell Dump Till	3,920	20	Biosolids (138 dt/ha)	Native grasses/forbes (35 kg/ha) (hand seeded)			2012	2012	2012	-	2012		
	Phase 2	2.87	Wildlife, forestry	North Bell Dump Top	4,680	20	Biosolids (135 kg/ha)	Native grasses + lupine (35 kg/ha) (hand seeded)			2012	2012	2012	-	2012		
	Metro Van Research Parcel 1	2.81	Wildlife, forestry	North Bell Dump Till	4,680	20	Biosolids (107 dt/ha) (on 2.34 ha)	1) No seed 2) Forbes mixture (75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix) 3) Fireweed (75 g/ha) 4) No seed 5) Native grasses/forbes (5kg/ha) 6) Native grasses/forbes (10 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry - 50 sph	Lodgepole pine - 1120 sph Douglas fir - 480 sph Consider underplanting with later successional species in future.	2012	2013	2013	-	2014	2014	2014
	Wrap Around Toe	2.20	Wildlife	North Bell Dump Till	14,418	6	None	Native grasses (~15 kg/ha) (hand seeded)	Monitor natural vegetation ingress		-	2012	-	-	2012	TBD - monitor ingress	
	Beside Research	2.00	Wildlife, forestry	Direct Placement: SEZ Stripping	4,000	20	None	Monitor natural growth from direct placement.			2012	2013	-	TBD - monitor ingress			
	Metro Van Research Parcel 2 (in Beside Phase 2 parcel 4.79 ha area)	2.00	Wildlife, forestry	North Bell Dump Top	4,000	20	Biosolids (107 dt/ha)	1) No seed 2) Forbes mixture (75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix) 3) Fireweed (75 g/ha) 4) No seed 5) Native grasses/forbes (5kg/ha) 6) Native grasses/forbes (10 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry - 50 sph	Lodgepole pine - 1190 sph Douglas fir - 510 sphh Consider underplanting with later successional species in future.	2012	2014	2014	-	2014	2015	2015
Waste Haul Road	Heli Pad Area	1.53	Wildlife, forestry	Old Cariboo Stockpile/ Springer Pit	3,825	28	18-19-18 Fertilizer (170 kg/ha)	Aggressive seed mix (26 kg/ha) (hydroseeded)	Monitor natural vegetation ingress	Douglas fir - 216 sph	-	2013	-	TBD - monitor ingress	2014		2015
	Above WHR (Pond Zone)	1.81	Wildlife, forestry	Old Cariboo Stockpile/ Springer Pit	5,456	30	None	Native grasses/forbes (22 kg/ha)	Monitor natural vegetation ingress		-	2013	-	TBD - monitor ingress	2013		
East RDS	Highway to Heaven	11.52	Wildlife, forestry	2014: Direct Placement: Cariboo Ore Stockpile, WX Zone Stripping 2015: Highway to Heaven	2014: 26,700 2015: 8,200	40	None	Native grasses/forbes (30 kg/ha)			2014 - 9.47 ha	2014 - 6.58 ha	-	TBD - monitor ingress	2014		
	Tree Plots[2]	2.13	Wildlife, forestry	Bell Pit Stockpile	Not Calculated	0 - 65	Amendment Tested: Fertilizer (RTI Bio Pack's, 10g/bag) Biosolids (50 - dt/ha) Tailings (20cm)	Domistic grasses (20kg/ha - 40 kg/ha) Native grasses/forbes (40 kg/ha) - two different mixtures	-	Lodgepole pine - 1400 sph Douglas fir - 600 sph	2000	1998 - 2000	1998 - 2000	-	1998 - 2000	-	1998 - 2000
	Above Access Road	3.78	Wildlife, forestry	Direct Placement: TSF Rd Stripping (Bootjack Creek), Cariboo Ore Stockpile, WX Zone	9,000	25	None	~ 0.75 kg/ha lupine ~2 kg/ha june grass, yarrow, pearly everlasting mix			2011	2014	-	TBD - monitor ingress	2014		

								~35 g/ha Fireweed (~1 ha on eastern side only) Remaining area: Native grasses/forbes (30 kg/ha)									
TSF		23.95	Wildlife, forestry, livestock	South Till Borrow	N/A	N/A	Biolids - 12.00 ha	Unknown			Unknown	N/A	Unknown	-	Unknown		
NEZ Dump	Parcel 2 (a/b)	5.13	Wildlife, forestry	Wight Till	20,000	40	2a: fertilizer (238 kg/ha) 2b1: biosolids 2b2: fertilizer (71 kg/ha), biosolids	Native grasses/forbes (handseeded) 2a: 45 kg/ha 2b: 34 kg/ha	Paper birch - 100 sph Trembling aspen - 100 sph Black cottonwood - 200 sph Sitka alder - 100 sph saskatoon - 100 sph wood rose - 100 sph Willow live stakes - 40 sph	Lodgepole pine - 1300 sph Douglas fir - 700 sph	2010	2010	2010	-	2011	2012	2012
Boundary Zone	Boundary Dump	4.70	Wildlife, forestry	PAG Dump Stripping	12,000	28	None	Monitor growth from direct placement and natural ingress (monitor invasive species establishment)			2011	2014	-	TBD - monitor ingress	Monitor growth from direct placement and natural ingress		

Notes:
1) Native grasses/forbes: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye, june grass, tickle grass, fireweed.
Native grasses: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye.
Aggressive seed mix: dahurian wildrye, slender wheatgrass, perennial ryegrass, timothy
2) Refer to summary reports on the tree plots for detailed information on the treatment units and research design

11 Mining Program

11.1 Surface Development to Date

At the end of 2018, the total disturbed area at the Mount Polley Mine site was 1,240.8 ha. Discussion of disturbed areas in this report does not include areas disturbed due to the TSF embankment breach as this area is beyond the scope of *Mines Act* Permit M-200. Table 11.1 provides a breakdown of disturbed areas by Mine component and serves to fulfill the annual reclamation reporting requirement for Table 1. These areas are also shown on the site facilities map in the *RCP* (MPMC, 2017a). Concurrently with surface development, progressive reclamation is ongoing. Table 10.2 provides the areas re-sloped, seeded, fertilized, and re-vegetated in 2018 and total reclamation to date. Minor area changes from previous years tables are a result of polygon refinement.

Table 11.1 Mount Polley Mine site existing and projected disturbance

Area	Existing Area	Closure Area (if changed)	Reclaimed Area	Lake Area	Reclamation Area
	(ha)	(ha)	(ha)	(ha)	(ha)
Dumps					
~~Bell Dump~~	-	-	-	-	-
Boundary Dump	4.84		4.70	-	0.14
East RDS	50.95		5.06	-	45.89
Highway to Heaven	16.24		9.47	-	6.77
NEZ Dump	22.90		5.13	-	17.77
North Bell Dump	62.08	***62.08***	22.31	-	39.77
SERDS	108.50	***108.50***	-	-	106.21
Temporary NW PAG Stockpile	76.34	***76.34***	-	-	74.19
Total	**341.85**	**341.85**	**46.67**	**-**	**290.74**
Pits					
Boundary Pit	12.10	***12.10***	-	2.74	5.28
~~C2 Pit~~	-	-	-	-	-
~~Cariboo Pit~~	-	-	-	-	-
~~Pond Zone Pit~~	-	-	-	-	-
TSF Quarry	11.04		-	-	11.04
~~SEZ Pit~~	-	-	-	-	-
Cariboo-Springer Pit	133.84	***133.84***	-	49.70	90.54
Wight Pit	38.70		-	14.61	22.95
Total	**195.68**	**195.68**	**-**	**67.05**	**129.81**
Stockpiles					

#1 Stockpile	10.91	***10.91***	-	-	10.91
Biosolids	2.84		-	-	2.84
High Ox Stockpile	10.23		-	-	10.23
Mount Polley Soil	4.06		-	-	4.06
NEZ Soil	9.41		-	-	9.41
Cariboo Ore Stockpile	8.83		-	-	8.83
Pond Zone	2.83		-	-	2.83
SERDS Soil Stockpile	11.66	***11.66***	-	-	11.66
Tailings Soil	2.95		-	-	2.95
Total	**63.72**	**63.72**	**-**	**-**	**63.72**
Roads					
Boundary/Wight Pit Connector Road	1.67		-	-	1.67
Crusher Road	2.29		-	-	2.29
Mill/TSF Connector Road	17.27		-	-	17.27
New Access Road	26.90		-	-	26.90
~~Old Mine Access Road (Bootjack) - Mine Component~~	-	-	-	-	-
~~Old Pond Zone Road~~	-	-	-	-	-
Old Tailings Haul Road	12.35		-	-	12.35
Old Wraparound Road	11.00		-	-	11.00
Ore Switchback Road	12.12		-	-	12.12
Polley Lake Access Road	0.72		-	-	0.72
West Haul Road	60.73	***60.73***	-	-	60.73
Wight Pit Haul Road	14.33		-	-	14.33
Wight Pit/Tailings Road	17.37		-	-	17.37
Total	**176.75**	**176.75**	**-**	**-**	**176.75**
TSF					
Corner 4 to Corner 5	11.34		-	-	11.34
Corner 4 to Corner 5 Light Duty Access Road	6.31		-	-	6.31
East Till Borrow	12.81		-	-	12.81
Hazeltine Discharge Pipe Grade	2.92		-	-	2.92
Main Embankment	30.36		-	-	30.36
Perimeter Embankment	44.61		-	-	44.61
South Embankment	9.17		-	-	9.17
Southeast Till Borrow	26.27		23.95	-	2.32

~~Tailings Pipe Grade~~	-	-	-	-	-
TSF - South and Main Ponds	9.40		-	-	9.40
TSF - Southwest Pond	3.83		-	-	3.83
TSF Surface	214.28		-	32.14	182.14
Total	**371.30**	**371.30**	**23.95**	**32.14**	**315.21**
Miscellaneous					
Geology Area	2.75		-	-	2.75
Helipad	3.13		1.53	-	1.60
Hydro Line	3.21		-	-	3.21
Long Ditch	7.94		-	-	7.94
Mill Area	20.19		-	-	20.19
~~Northwest PAG Ditch~~	-	-	-	-	-
~~Old Dispatch~~	-	-	-	-	-
Old Orica Sites	1.79	***1.79***	-	-	1.79
South SERDS Ditch	2.65	***2.65***	-	-	2.65
Warehouse Area	13.64		-	-	13.64
Constructed Treatment Wetland System	-	***1.05***			1.05
West Ditch	11.52		-	-	11.52
Total	**66.82**	**67.87**	**1.53**	**-**	**66.34**
Total Disturbed Area:	**1,240.80**	**1,217.17**	**72.15**	**99.19**	**1,042.57**

11.1.1 Underground Mining Program

No mining occurred in the Wight Pit in 2018. It has been in Care and Maintenance since May 2017.

11.2 Projected Mine Life

Current operating permit is until December 31, 2022.

11.3 Projected Surface Development

The projected closure disturbance area for the four-year Mine plan is 1,302.01 ha, which is a total increase of 1.09 ha over the existing (December 31, 2017) Mount Polley Mine site footprint. This increase in disturbance is the result of the development of components under the authorized Mine plan, including pits (continued mining), SERDS and Temporary NW PAG Stockpile development (material placement), and road infrastructure (i.e., the Tailings Dam Access Road; TDAR).

The projected changes in disturbed areas with the closure footprint are outlined in Table 11.2. Existing and projected disturbance can be found in Table 11.1. Further information on projected surface development can be found in *RCP* (MPMC, 2017a).

Table 11.2 Changes in disturbed areas with closure footprints

Area	Existing Area (ha)	Closure Area (if changed) (ha)	Delta	Description
Dumps				
North Bell Dump	62.47	*62.07*	-0.40	Cariboo-Springer Pit Expansion
SERDS	109.97	*110.27*	0.30	Final resloped footprint
Temporary NW PAG Stockpile	80.48	*77.93*	-2.55	Final resloped footprint
Pits				
Boundary Pit	12.26	*19.41*	7.15	Boundary Pit Development
Cariboo-Springer Pit	145.77	*163.57*	17.80	Cariboo-Springer Pit Development
Stockpiles				
#1 Stockpile	10.76	*10.06*	-0.70	Cariboo-Springer Pit Expansion
SERDS Soil Stockpile	12.76	*12.09*	-0.67	SERDS Expansion
Roads				
West Haul Road	59.21	*103.72*	44.51	Assumes completion of TDAR; if not, no additional disturbance.
Miscellaneous				
Old Orica Sites	1.73	*0.76*	-0.97	TDAR Construction (West Haul Road)
South SERDS Ditch	2.61	*0.40*	-2.21	TDAR Construction (West Haul Road)
CWTS	1.05	*1.05*		CWTS Construction 9k Sump

11.4 Salvaging and Stockpiling of Surficial Materials

11.4.1 Volumes and Storage Locations

As per the *MPMC Soil Management Plan* in the *RCP* (MPMC, 2017a), MPMC tracks volumes and locations of soil stockpiles and has a sampling program in place to characterize soil suitability for reclamation. In 2018 the following transfers were completed:

- 1,517 m^3 was removed from the Lower SERDS 1 stockpile and moved to the CTWS;
- 661 m^3 was removed Lower SERDS 2 to the NEZ Sump; and
- 2399 m^3 was removed from Lower SERDS 1 to the Corner 1 Buttress

Soil transfers were used for small project work in 2018. Table 11.3 summarizes the quantities of soil at the Mine site and meets the requirements for EMPR reporting for Table 5.

Table 11.3 MPMC Soil Inventories as of Dec. 31, 2018.

Stockpile Name	Location	Soil Volumes (m^3)
TSF Corner 1 - Windrow	TSF Corner 1	5,100
Upper Plug Acces Road (PAR) - Windrow	Along upper PAR	1,700
Plug - Stockpiles	Polley Lake Plug	127,017
Perimeter Pond - Stockpile	Bottom of Corner One (near old Perimeter Pond)	4,700
Till Borrow - Windrow	North of (Perimeter) Till Borrow	42,800
Perimeter Embankment - Windrow	Edge of Perimeter Embankment	3,800
Main Embankment - Stockpile	SE of Main Embankment	94,900
South Till Borrow - Stockpile 1	NW stockpile in South Till Borrow	11,600
South Till Borrow - Stockpile 2	S stockpile in South Till Borrow	65,300
South Till Borrow - Stockpile 3	NE stockpile in South Till Borrow	9,600
Gavin Lake Road - Windrow	Gavin Lake Road (along South/Main Embankment)	24,200
TDAR - Windrow	Adjacent to TDAR	43,500
Tailings Reclaim Road - Windrow	Tailings Reclaim Road	44,300
Cariboo Stockpile - Stockpile	Below Cariboo Stockpile	33,967
Mill Site - Stockpile	East of Mill/Admin Building (includes berms)	10,700
Access Road km 11.5 - Stockpile	Across from NBD Reclamation Parcels 1 - 10	8,200
Access Road km 12 - Stockpile	S-SW of Mount Polley Peak (by km 12 on Acces Rd)	83,700
East RDS - Stockpile	Top of East RDS	58,500
Leach Pad - Stockpile	Top of East RDS	4,800
Highway to Heaven - Windrow	Highway to Heaven Access Road	21,500
NEZ Dump Top - Stockpile	Top of NEZ Dump	6,500
		25,000
NEZ Dump Lower - Stockpile	Off Wight Pit Haul Road	71,300
Wight Pit Till - Stockpile	Bottom of Wight Pit Haul Rd	135,100
Wrap Around Road - Windrow	Wight Pit - TSF Connector Road (below NEZ Dump)	101,600
North Bell Dump Till - Stockpile	North Bell Dump	164,000
North Bell Dump Top - Stockpile	Top of North Bell Dump	8,500
Springer North	Between North Bell Dump and Springer Pit	20,000
NW Sump Road - Windrow	NW Sump Road	7,500
PAG Dump - Windrow	Below PAG Dump	39,300
SEZ 1 - Stockpile	Top of Old Pond Zone Pit	108,687
SEZ 2 - Stockpile	Top of SERDS (near SEZ - 1)	14,000
SEZ-3	Below Co-mingling Project	65,700
SEZ-4	Below Co-mingling Project / SERDS	22,600
SERDS - Stockpile	Below SERDS Dump	58,000
Old TSF Haul Road	Along old TSF Haul Road (SERDS)	27,200
Lower SERDS - Stockpile 1	Below SERDS Dump	27,870
Lower SERDS - Stockpile 2	Below SERDS Dump	27,539
Lower SERDS - Stockpile 3	Below SERDS Dump	140,100
TDAR Sand/Soil Stockpile	TDAR	46,425
	Total Volume of Stockpiled Soils	**1,816,805**

Further details regarding soil balance and usage during progressive and final reclamation can be found in *RCP* (MPMC, 2017a).

11.4.2 Soil Stockpile Inspections

All non-active soil stockpiles on site are regularly inspected for erosion and vegetative cover and any non-active stockpiles requiring additional vegetative cover and/or showing signs of erosion are added to the bi-annual (spring and fall) seeding list.

11.4.3 Soil Stockpile Quality

MPMC did not undertake stockpile sampling and characterization in 2018. A stockpile sample program was undertaken in 2013 and 2014. Information regarding stockpile quality can be found in MPMC 2013 and 2014 *AERR*s (MPMC, 2014, 2015b).

MPMC is collaborating with researchers from the Department of Forest and Conservation Sciences at the University of British Columbia to assess changes in the biological communities of stockpiled soil. Soil organisms play a critical role in nutrient cycling, contribute to development of soil structure and form symbiotic mutualistic relationships with plants. Yet during storage, soil can undergo degradation (e.g., die-off of vegetative propagules and decreases in available nutrients) reducing its quality for use in reclamation. This project aims to quantify changes in soil biological communities and understand the time periods over which they occur.

In August 2018, samples were collected from five stockpiles around the Mine site representing a chronosequence of stockpile ages:

1. Mill Site (1995)
2. East RDS (2000)
3. Wrap Around Road (2010)
4. Perimeter Access Road (2015)
5. Cariboo Stockpile (2017)

Three replicate locations were sampled for each stockpile (except only one (1) site was sampled for the mill site) with samples being collected at surface and depth (1 m) to assess changes in soil properties over time when stored at the surface versus at depth. Control samples were collected from three reference forest areas. The following trophic levels and functional groups of the soil food web are being assessed: macrofauna (through hand sorting in the field), mesofauna (through funnel extractions) and microbes (through phospholipid fatty acid analysis). Vegetation diversity and abundance, root biomass and soil samples for physical and chemical parameters were also measured to assess to aid in interpretation of biological community results. MPMC expects results from this experiment to be available in 2019.

11.5 Acid Rock Drainage/Metal Leaching Characterization Program and Waste Disposal

11.5.1 Waste Rock Characterization and Disposal

Active monitoring of ARD/ML potential in the Mount Polley waste rock continued in 2018 as part of the established protocol which encompasses two stand-alone acid-base accounting (ABA) procedures: ARD analysis of diamond drill core pulps to model a preliminary PAG body; and ongoing ABA determination of individual blast hole samples during mining operations to enhance the segregation of PAG from non-acid generating (NAG) waste (RCP, 2017a). The program characterizes all material types that will be handled during the Mine life. Analysis is completed on site by Mount Polley's LECO™ analytical machine which allows the Mine to characterize waste and direct it to suitable storage sites or designate it for construction usage when required and if deemed suitable.

On each bench, a sample of cuttings is collected from each blast hole and analyzed for total copper, non- sulphide copper, iron, and gold. In 2018, blasthole patterns were 7.4m by 8.5m or 7.0m by 8.0m in the Cariboo Pit and the bench height remained at 12 m. Areas of ore and waste are identified by indicator kriging and assigning assay values, mill head value, etc. using an inverse distance calculation. The ore control staff member then establishes ore/waste boundaries based on the calculated mill head values. Mill feed ore areas are excluded from ABA analysis, as this material is processed through the mill. Only waste rock is submitted for ABA analysis. The waste rock material was sampled at minimum frequency of one (1) sample per 10,000 t of rock in 2018 as an increased QA/QC sample check to minimize the chance of PAG in waste rock piles as of 2016. Survey data by pit is included in Appendix N of this report.

Samples with both a Neutralizing Potential Ratio (NPR) greater than 2 and a sulphur content less than 0.1% are considered NAG, and samples with both a NPR less than 2 and a sulphur content greater than 0.1% are considered PAG. PAG is currently stored in the Temporary NW PAG Stockpile to the northwest of the Springer Pit and will be relocated to the bottom of the Springer Pit and submerged upon Mine closure.

A summary of quantities of waste rock, tailings, and other Mine waste added to site storage areas in 2018 and the total quantities on site as of December 31, 2018 is provided in Table 11.4 and fulfills the EMPR requirements for Table 2 and is included in Appendix N.

Table 11.4 Quantities of waste rock, tailings, low grade ore, and other mine waste as of December 31, 2018.

Name of Waste Pile or Pond	Acid Generating Waste (tonnes)		Potentially Acid Generating Waste (tonnes)		Non-Acid Generating Waste (tonnes)	
	2018	Total	2018	Total	2018	Total
Waste Dumps						
Waste Haul Roads	0	0	0	0	37,020	11,281,815
South East NAG Dump	0	0	0	0	3,664,718	60,066,483
Temporary PAG Stockpile	0	0	212,975	24,330,411	0	72,512,935
NEZ Dump/Wight Pit Dump	0	0	0	0	0	359,759,809
Temporary Rock Stockpile	0	0	0	0	0	25,074
Total	0	0	212,975	24,330,411	3,701,738	503,646,116
Tailings Pond						
HAC Construction Material	0	0	0	0	4,485	29,797
TSF Area Construction Material	0	0	0	0	597,713	3,765,303
Total	0	0	0	0	602,198	25,682,160
Low Grade Ore/Coarse Reject/Other Mine Waste						
Low Sulphur Waste	0	0	0	0	0	752,433
Low Grade Stockpile	0	0	0	253,716	0	10,414,779
Total	0	0	0	253,716	0	11,167,212
Water Treatment Plant - Total	0	0	0	0	0	39,511

11.5.1.1 Springer Pit

No productive mining occurred in the Springer Pit in 2018. Note that any material from the Springer Pit mining zone refers to any cleanup that may have been needed for the dredging project.

11.5.1.2 Cariboo Pit

The majority of the Cariboo Pit waste that was blasted in 2018 was NAG. One (1) sample per 10,000 t of rock was collected from the pit and submitted for ABA analysis. PAG was identified in ten (10) grab samples characterized as NAG in 2018, which equates to approximately 3% of total samples. Those samples were improperly identified. The Cariboo Pit NAG waste was hauled to either to the SERD, the TSF buttressing project or other projects. The PAG was dumped to the west of the Springer Pit in the Temporary NW PAG Stockpile. A summary of what was mined in the Cariboo Pit is provided in Table 11.5 and fulfills the EMPR requirements for Table 3 and is included in Appendix N. From late May to early August, no mining occurred due to a strike by the unionized employees. Note that the differences in tonnages between tables reflect error margins on haul truck counts and additional sub-surface rock extraction.

11.5.1.3 Wight Pit/Underground

No mining occurred in the Wight Pit in 2018. It has been in Care and Maintenance since May 2017.

Table 11.5 Summary of monthly mining production in 2018

Mining Summary						
Month	**Pit**	**Total Ore Mined (t)**	**NAG Waste (t)**	**PAG Waste (t)**	**Overburden (t)**	**Total Waste (t)**
January	Cariboo	637,639	1,223,487	85,133	0	1,271,736
February	Cariboo	499,488	604,045	63,369	0	667,414
March	Cariboo	498,365	869,124	5,892	0	875,016
April	Cariboo	385,528	449,794	24,462	0	474,256
May	Cariboo	221,128	389,018	18,686	0	407,704
June	Cariboo	0	0	0	0	0
July	Cariboo	0	0	0	0	0
August	Cariboo	172	41	0	0	41
September	Cariboo	499,400	348,509	15,433	0	363,942
October	Cariboo	355,788	306,812	0	0	306,812
November	Cariboo	161,613	74,773	0	0	74,773
December	Cariboo	57,697	3,746	0	0	3,746
Total		3,316,818	4,269,349	212,975	0	4,482,324

11.5.1.4 ABA Data

There were 375 ABA samples analyzed in 2018. Approximately 5% of the waste mined was PAG. These samples were collected to characterize the ML/ARD potential of possible materials milled. ABA samples are collected from blastholes in the pit and from waste stockpiles. No ABA samples were taken from ore stockpiles as the blasthole ABA samples will have already provided a profile of the material. The results of these analyses are summarized here in Table 11.6 and the raw data are tabulated in Appendix N. Note that the differences in tonnages between tables reflect error margins on haul truck counts and additional sub-surface rock extraction.

Table 11.6 Summary of ABA data from the operating pits in 2018.

Pit	Samples	Tonnes	NPR	NP	C (%)	AP	S (%)
Cariboo - NAG	193	4,488,956	6.41	11.38	0.14	1.78	0.06
Cariboo - PAG	182	212,975	2.52	9.96	0.12	3.94	0.12
Total	375	4,701,931	3.78	10.69	0.13	2.83	0.09

11.5.1.5 Field Grab Samples

In 2018, thirty-nine (39) ABA grab samples were collected from active waste rock dumps for QA/QC purposes during periods when PAG was mined. One (1) sample was split and analyzed by the MPMC lab and ALS Laboratory as an annual QA/QC check. One (1) sample was collected from the temporary PAG dump. Due to the cyberattack, ABA data from January to May were lost. During the strike from late May to early August, there was no PAG mined, therefore, no ABA grab samples were collected. From the results that are available from August to December, four samples taken from NAG dumps resulted in a sulphur content of >0.1% but had an NPR >2, therefore constituted as NAG. One (1) sample collected had a NPR of <2, but a sulphur content of less than 0.1%. No ABA grab samples from the NAG stockpiles or construction areas had a NPR of <2 and a sulphur content of >0.1%. Results for the LECO™ analysis for these are included in Appendix N.

11.5.1.6 Tailings Storage Facility

Total NAG pit material moved to the dam in 2018 for construction purposes was 539,615 t. The material was used for the Corner 1 buttress reconstruction project of the TSF after the 2014 embankment failure. No TSF reclamation was conducted in 2017. Details on future TSF reclamation activities are provided in the *RCP* (MPMC, 2017a).

11.5.1.7 Tailings

Representative composite tailings samples were collected and analyzed for ABA every month when processing of ore occurred to represent the tonnage of tailings. From January 1 to December 31, 2018, approximately 6,166,566 t of tailings were deposited into the TSF. The monthly average rate of discharge of tailings slurry is approximately 46,000 m^3 per day. Table 11.7 displays the ABA data for each of the tailings composite samples for 2018. Note that data from January to June were lost due to the cyberattack attack. The composite tailings samples had an average NPR value of 6.327 and range NPR values from 5.59 to 8.49.

Table 11.7 ABA results from 2018 monthly tailings composite samples

Month	Tailings Composite NPR
January	-
February	-
March	-
April	-
May	-
June	-
July	5.79
August	5.7
September	8.49
October	5.59
November	6.37
December	6.02
2018 Average	**6.33**

11.5.1.8 Monthly Milling Rates

The total amount of ore sent to the crusher in 2018 was 6,406,614 t. Mill feed extracted from the Cariboo Pit equaled 41%, while the remaining 59% was mined from the ore stockpiles. From late May to early August, no mining occurred due to a strike by the unionized employees, and mill feed came from stockpiles. A monthly summary of the various ore feeds is provided in is provided in Table 11.8 and monthly custom milling production in Table 11.9 fulfill the EMPR requirements for Table 4 and is included in Appendix N.

Table 11.8 Summary of monthly milling rates in 2018

Crusher Mill Feed Summary				
	Source			
Month	**Cariboo Pit Crusher Feed (t)**	**Stockpiles to Crusher Feed (t)**	**Total Crusher Feed (t)**	**Cariboo Ore to Stockpiles (t)**
January	412,316	154,915	567,231	225,323
February	408,161	123,321	531,473	91,327
March	428,937	149,217	578,154	69,428
April	339,240	234,470	573,710	46,288
May	161,901	433,356	595,257	59,227
June	0	439,656	439,656	0
July	0	224,288	224,288	0
August	172	608,510	608,691	0
September	473,092	123,849	596,941	26,173
October	276,777	290,436	567,213	79,011
November	97,295	487,362	584,657	64,318
December	25,387	513,956	539,343	32,310
Total	**2,623,278**	**3,783,336**	**6,406,614**	**693,405**

The total ore milled in 2018 was 6,195,760 t with a daily average target of 21,000 t. A summary is provided in Table 11.9. The 0.03% tonnage discrepancy of total crusher feed from Table 11.7 and total mill feed from Table 11.8 comes from error in the haul truck counts of material delivered to the crusher, as mine operations assumes a constant tonnage for every haul truck coming out of the pit. The mill receives crushed ore from the crusher by conveyor belts, which measure the actual tonnage of material feeding the mill.

Table 11.9 2018 mill production summary

Mill Production Summary								
Month	Feed Tonnage (tonnes)	Tails Tonnage (tonnes)	Feed Grades (Corrected Month End)			Metal Produced		
			Copper (%)	Gold (g/t)	Oxide Ratio	Cu (lbs)	Au (oz)	Ag (oz)
January	575,729	572,263	0.192	0.299	13.836	1,803,762	3,924	2,830
February	490,870	487,763	0.201	0.321	12.430	1,702,614	3,815	3,235
March	545,887	542,260	0.206	0.344	13.981	1,865,124	4,541	2,900
April	565,345	562,101	0.217	0.320	29.916	1,589,159	4,104	3,854
May	568,877	566,069	0.171	0.252	18.464	1,402,767	3,134	2,361
June	448,722	447,060	0.145	0.198	21.890	827,207	1,872	1,317
July	274,629	273,666	0.196	0.209	34.603	484,195	1,182	1,176
August	565,005	564,054	0.268	0.263	64.578	391,232	2,515	3,094
September	553,735	550,345	0.184	0.297	12.147	1,723,846	4,051	3,414
October	521,617	519,142	0.188	0.306	15.280	1,543,671	3,836	3,173
November	568,789	566,456	0.228	0.215	47.994	965,930	2,144	3,318
December	516,556	515,388	0.275	0.259	58.794	674,123	2,002	2,786
Total	**6,195,760**	**6,166,566**	**0.207**	**0.277**	**28.615**	**14,973,630**	**37,120**	**33,458**

11.5.1.9 Rock Borrow Pit

No rock was extracted from the rock borrow in 2017.

11.6 Drainage Water Quality Monitoring

An important component in determining and monitoring long-term chemical stability of drainage from the pits and waste rock dumps is water quality monitoring. Locations monitored by MPMC (in addition to sampling required under the *Mines Act* Permit M-200 and *EMA* Permit 11678 [refer to the *CEMP* in Appendix A]), sampling periods, and sampling frequencies are provided in Table 11.10.

These water collection facilities and drainage monitoring locations are shown in Appendix B. MPMC continued the bi-annual seep survey program of all rock waste dumps on site in 2018, with representative seeps being monitored monthly or quarterly when possible (numerous seeps stop flowing during dry periods). Seep monitoring locations are shown in Appendix B. Note that when field parameters of adjacent seeps are consistent, typically only the seep with larger flow is sampled. Results are reported in Appendix E. Collection of this data are used in long-term water quality predictions.

Table 11.10 Site drainage water quality monitoring locations, and sampling periods and frequencies

Sample Location	Drainage Area	Sampling Period	2016 *CEMP* Sampling Frequency	2018 *CEMP* Sampling Frequency
Cariboo Pit Sump (E8)	-	1997 – current	Bi-annually[1]	Bi-annually[1]
Wight Pit (E10)	-	2006 – current	Bi-annually	Bi-annually
Pond Zone Pit Sump (E12)	-	2010 – 2012	N/A	N/A
Springer Pit Sump (E11) [2]	-	2011 – current	Monthly[1]	Bi-annually[1]
Boundary Pit	-	2012 – current	Bi-annually	Bi-annually
Joe's Creek Pipe	NBD seep	2010 – current	Monthly	Quarterly
Long Ditch	East RDS, NEZ Dump, SERDS, Wight Pit dewatering	2008 – current	Quarterly	Quarterly
SERDS Ditch	SERDS, West Ditch, MDC Sump	2012 – current	Quarterly	Quarterly
NW Sump (E13)	Temporary NW PAG Stockpile, NW Ditch	2012 – current	Quarterly	Quarterly
Mine Drainage Creek Sump (E14)	Upper Mine Drainage Creek, West Ditch	2013 – current	Quarterly	Quarterly
Bootjack Creek Culvert Sump (E15)	TSF Access Road, Upper Bootjack Creek	2013 – current	Quarterly	Quarterly
9km Sump (E17)	Temporary NW PAG Stockpile, Junction Zone Ditch	2014 – current	Quarterly	Quarterly
TSF Supernatant (E1a)	Tailings slurry, seepage collection ponds	1997 – 2014, 2016 – current	Monthly[3]	Quarterly[3]
MESCP (E4)	MTD, STD, Main Embankment foundation drains	2001 – current	Quarterly	Quarterly
PESCP (E7)	Long Ditch, SERDS Ditch, PTD	2001 – 2014	N/A	N/A
Central Collection Sump (E18)	Long Ditch, SERDS, Ditch, PTD, MESCP, South Embankment Seepage Collection Pond, TSF (as of 2016)	2014 – current	Quarterly	Quarterly
East/West Main Toe Drains (MTDs)	TSF Main Embankment toe drains	1998 – current	Quarterly	Quarterly
Perimeter Toe Drain (PTD)	TSF Perimeter Embankment toe drain	2009 – 2014	N/A	N/A
South Toe Drain (STD)	TSF South Embankment toe drain	2011 – current	Quarterly	Quarterly

[1] when pit is not storing water from other sources on site
[2] Not accessible due to ongoing dredging operations
[3] when barge in TSF is supplying reclaim water to mill; started sampling November 2016

No obvious trends in the water quality at the drainage location sampling sites have been observed. This is consistent with SRK ore characterization and geochemical source term reports (SRK 2015b; 2016).

11.6.1 Long-Term Predictions – Kinetic Testing

Kinetic rate information is an important component of drainage chemistry prediction that provides a measure of the dynamic performance or "reactivity" of the material being tested. Stephen Day, MSc, PGeo, of SRK has been retained to interpret results of the ongoing kinetic-testing program and recommend additional testing, if required. The most updated report was submitted as an appendix of the 2012 *AERR* (MPMC, 2013). Sample HC13 from the Pond Zone (humidity cell and three column tests) initiated April 20, 2009 is the only test currently running. Additionally SRK completed a report describing the derivation and use of the source terms (SRK, 2016) for the TAR submitted to ENV for the long-term water management application (Golder, 2016b).

11.6.2 Test Heap Leach

In 2006, Mount Polley applied for an amendment to the *Mines Act M-200 Permit* allowing them to build a Heap Leach Pad and Copper Recovery facility. The amendment was granted on March 29, 2007. The *Mines Act M-200 Permit* requires that all monitoring data from the facility be included in this report.

In 2014, Mount Polley participated in a research project with Kemetco Research who has been developing a sulphur oxidation bioreactor system for potential use in generating sulphuric acid for copper oxide heap leaching. The heap leach at Mount Polley has been decommissioned until the research is complete. Three batch tests were started at Kemetco Research, but the project has been postponed since the TSF embankment breach. One (1) leachate sample was collected in May 2018; the concentrations for total aluminum, total copper, and total iron were 1120 mg/L, 308 mg/L, and 34.5 mg/L, respectively. Table 11.11 shows the sump levels in 2018.

Table 11.11 Heap leach sump level in 2018

Month	Heap Leach Sump Level (ft)
January	7.00
February	7.99
March	10.77
April	19.99
May	8.57
June	4.80
July	5.04
August	7.24
September	5.01
October	9.07
November	15.84
December	2.95

11.6.3 Sulphur Pile

Approximately 10,259 t of sulphur were acquired by MPMC from 2006-2008 to facilitate the production of sulphuric acid at the Heap Leach Pad. In 2018, elevated copper concentrations were discovered in the LD and, through an extensive investigation, traced back to NEZ Seep 1 and 2. Further investigations identified the sulphur pile as being a source of sulphuric acid which has leached into the underlying waste rock. The rock has neutralized the acid, but potentially it has resulted in elevated metal concentrations in the seepage. Research is ongoing into the geochemical performance of the affected rock and is expected to be published later in 2019. To prevent ongoing leaching, the sulphur pile was moved to the LCRS in October 2018. A sump was constructed at the base of the NEZ waste rock pile to collect the affected NEZ seeps; the sump is pumped to the mill except during freezing periods when it is piped to the Wight Pit. Monitoring of the affected NEZ seeps will continue in 2019.

11.7 Air Discharge Permit

In 1997, MPMC was issued an Air Discharge permit, (under the former *Waste Management Act)* by ENV. There are no reporting requirements for this *EMA* Permit 15087.

11.8 Refuse Permit

In 1997, MPMC was issued a Refuse permit, (under the former *Waste Management Act)* by ENV. There are no reporting requirements for this *EMA* Permit 14590.

11.9 Biosolids Permit

In 1999, MPMC was issued a Biosolids permit, (under the former *Waste Management Act)* by ENV. All reporting requirements are presented in Section 10.5.1.

12 Summary and Conclusions

The 2018 monitoring program achieved the objectives as outlined in the 2016 *CEMP* and the 2018 *CEMP*. The *CEMP* is designed to integrate environmental monitoring programs currently being carried out at the mine to meet multiple ENV requirements. In addition to presenting data and review from 2018, the *EMA* Permit 11678 requires a three (3) year detailed monitoring program interpretive report. This *AERR* fulfills this requirement.

Environmental monitoring in 2018, and discussion related to data from 2016 to 2018 included:

- Chemistry and quantity of surface, seepage, lake and ground water;
- Sediment chemistry;
- Aquatic biology (toxicity testing, fish and benthic community studies, plankton, periphyton, fish, and benthic tissue chemistry);
- Hydrology of groundwater and surface water flows and levels;
- Meteorology (temperature, precipitation, snowpack, evaporation rates); and
- Terrestrial monitoring.

From 2016 to 2018, monitoring of effluent discharge showed compliance with all parameters with some exceptions. In 2018, there were six (6) instances of results triggering the *EMA* Permit 11678 limit exceedances at compliance locations (Sections 6.2.4; 6.2.6.1). There were no toxic effects on the environment. The WTP operated intermittently in 2018 and discharged a total of 5,174,175 m^3 of treated water.

The technical memo provided by Tetra Tech (Appendix I) suggests a gradual increase of dilute effluent under the thermocline that is expected to flush out during the spring and fall overturns. Continued efforts will be made to locate the plume when sampling (only during periods of discharge). Monitoring at the IDZ remains a safety challenge that MPMC continues to discuss with ENV.

In 2018, ENV approved the *ADP* which includes a *TRP*. This plan is used as a guidance document for MPMC for monitoring the discharge and for reviewing and responding to current water quality results. As noted in 2016 and 2017, the maximum results for total copper at the IDZ were similar when the WTP was discharging and not discharging. It is worth noting that there are many inputs into Quesnel Lake, which are contributing to the total copper in the lake, and that MPMC's discharge is not the sole contributing factor (Section 6.2.6).

Lake water quality data from Bootjack, Polley, and Quesnel Lake spanning 2016 to 2018 continue to meet BC WQG with some exceptions described in Section 8.2. Secchi disk readings continue to be similar or better than background readings (prior to 2014) (Section 8.6.2).

A detailed review of sediment, periphyton, fish community and tissue, plankton, and benthic invertebrates data from 2016 to 2018 in breach affected and reference areas was completed by Minnow and is included in Appendix J.

Mine site surface water and groundwater monitoring results were consistent with previous years monitoring and no significant changes to groundwater quality have been identified in 2018. In 2016 and 2017, Springer groundwater wells displayed similar trends to surface water elevations within Springer Pit. In 2018, as the Springer Pit was being dredged, groundwater elevations continued to decrease and no groundwater leakage from Springer Pit to Bootjack Lake occurred. A detailed review from Golder is included in Appendix F and summarized in Section 5.2.

In 2018, terrestrial monitoring on the Mine site. The data collected from breach related areas were used to address some of the uncertainties from the *ERA* (MPMC 2017c) including amphibian hazard and risk assessments (Section 7.8). Wildlife continued to be monitored in 2018, but observations were lower than in previous years due to the union strike and cyberattack. There was one (1) wildlife incident in 2018 (Section 9.1).

No significant new disturbance occurred in 2018. One (1) minor area of new disturbance, the construction of an on-site CWTS (Section 10.5.2.2). Progressive reclamation activities in 2018 included applying soil over 2.89 ha and planting trees over a 22 ha area. In 2018, a portion of Reach 3 of middle Hazeltine Creek underwent channel reconstruction, fish habitat installation and floodplain contouring and seeding (Section 7.11).

In 2018, Mount Polley Mining Corporation mined 3,316,818 tonnes of ore and 4,482,324 t of waste rock from the Cariboo Pit. Approximately 5% of the waste mined was PAG and was transported to the Temporary PAG Stockpile. Approximately 6,166,566 t of tailings were deposited into the Tailings Storage Facility. In 2018, MPMC milled 6,195,760 tonnes of ore. Next year's production is projected to end with the mill shut-down as part of a Care and Maintenance program that will go into effect May 31, 2019.

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13 References

Cariboo Chilcotin Coast Invasive Plant Committee [CCCIPC]. (2018). *2018 Regional Strategic Plan for Invasive Plant Management* and *Executive Summary*. Retrieved from the CCCIPC website: http://cccipc.ca/index.php/S=0/resources/regional-strategic-plans

Contango Strategies Ltd [Contango]. (2017). *CWTS Feasibility Assessment Report for Mount Polley Mining Corporation*. Prepared for Mount Polley Mining Corporation, July 2017.

Environment and Climate Change Canada [ECCC], (2018). *Metal and Diamond Mining Effluent Regulations*. Fisheries Act SOR/2002-22. Retrieved from Justice Laws website: https://laws-lois.justice.gc.ca/PDF/SOR-2002-222.pdf

Ministry of Energy, Mines, and Petroleum Resources [EMPR]. (2017). *Health, Safety and Reclamation Code for Mines in British Columbia*. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/code-review/health_safety_and_reclamation_code_2017_rev.pdf

Ministry of Environment and Climate Change [ENV]. (1981). *Snow Survey Sampling Guide*. Surface Water Section, Water Management Branch, Province of British Columbia. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/snow/snow_survey_sampling_guide.pdf

ENV. (2002). *Forest and Range Practices Act*. Retrieved from the BC government website: http://www.bclaws.ca/civix/document/id/complete/statreg/02069_01

ENV. (2013). *British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples*. Retrieved from the BC government website: https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

ENV. (2017). *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary* Report. Retrieved from the BC government website. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/bc_env_working_water_quality_guidelines.pdf

ENV. (2018). *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report*. Water Protection & Sustainability Branch. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

FCSAP (Federal Contaminated Sites Action Plan). 2016 Draft. *Ecological Risk Assessment Guidance, Module 6: Ecological Risk Assessment for Amphibians on Federal Contaminated Sites*. 127 pages.

Golder Associates Ltd., [Golder]. (2015a). *Mount Polley Mine: Short Term Effluent Discharge Technical Assessment Report in Support of an Effluent Permit Amendment*. Report prepared for MPMC. May 29, 2015.

Golder. (2016a). *Mount Polley Mine – Prediction of Water Level and Seepage from the Springer Pit and Bootjack Lake Water Quality Technical Memorandum*. Prepared for MPMC, March 7, 2016.

Golder. (2016b). *Mount Polley Mine: Long-Term Water Management Plan Permit Amendment Application under the Environmental Management Act Technical Assessment Report.* Prepared for MPMC, October 17, 2016.

Golder. (2017a). *Summary of Hydrogeological Assessments Conducted Until March 2017 Springer and Cariboo Open Pits – Mount Polley Mine Technical Memorandum.* Prepared for MPMC, August 16, 2017.

Golder. (2017b). *Geomorphic Slope Guidance Document*. Prepared for MPMC, December 15, 2017.

Golder. (2018a). *Progress Report 2: Mount Polley Mine 2018 Copper Removal Optimization Technical Report*. Prepared for MPMC, August 24, 2018.

Golder. (2018b). *Progress Report 3: Concept Design of TMT Dosing System for Dissolved Copper Removal During Freshest Field Trials – Mount Polley Mine Technical Memo.* Prepared for MPMC, December 21, 2018.

Golder. (2018c). *Soil Cover Test Plots Design, Construction, and Performance Monitoring*. Prepared for MPMC, June 1, 2018.

Hudson, R., and J. Fraser, (2005). *Introduction to salt dilution gauging for streamflow measurement, part IV: the mass balance (or dry injection) method.* Streamline Watershed Management Bulletin, 9(1), 6- 12.

Hunt, J., Holmes, G., and McMahen, K. (2018). *Biosolids and Conifers: Friends or Foes? Competition between Herbaceous Vegetation and Conifer Seedlings on a Biosolids Amended Rock Disposal Site at Mount Polley Mine.* University of British Columbia and British Columbia Technical Research and Reclamation Committee Symposium. Retrieved from the University of British Columbia library: https://open.library.ubc.ca/cIRcle/collections/59367/items/1.0374925

Knight Piésold Ltd, (2009). *Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek*. Letter to Mr. Ron Martel, Mount Polley Mining Corporation from Amanda Strouth, Greg Smythe and Ken Brouwer. May 11, 2009.

Meays, C, (2012). *Derivation of water quality guidelines to protect aquatic life in British Columbia*. Science Information Branch, Ministry of Environment, Victoria, BC.

Ministry of Attorney General. (2017). *Hazardous Waste Regulations.* Environmental Management Act. Retrieved from the BC government website: https://www2.gov.bc.ca/gov/content/environment/waste-management/hazardous-waste/legislation-regulations

Minnow Environmental Inc. [Minnow] (2011). *Mount Polley Mine Selenium Monitoring 2009/2010*. Prepared for Mount Polley Mining Corporation, March 2011.

Minnow. (2013a). *Mount Polley Mine Selenium Monitoring 2012*. Prepared for Mount Polley Mining Corporation, March 2013.

Minnow. (2013b). *Mount Polley Mine Selenium Monitoring 2013 Update Report*. Prepared for Mount Polley Mining Corporation, December 2013.

Mount Polley Mining Corporation [MPMC]. (2013). *2012 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2013.

MPMC. (2014). *2013 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2014.

MPMC. (2015a). *Post-Event Environmental Impact Assessment Report – Key Findings Report*. Prepared for MPMC by Golder Associates. Submitted to Ministry of Environment, June 5, 2015.

MPMC. (2015b). *2014 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2015.

MPMC. (2016a). *Update Report: Post-Event Environmental Impact Assessment Report*. Submitted to Ministry of Environment, June 3, 2016.

MPMC. (2016b). *2015 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2016.

MPMC. (2016c). *Hazeltine Creek Fish Exclusion and Response Plan Rev1*. Submitted to Ministry of Environment, May 5, 2016.

MPMC. (2017a). *Mine Reclamation and Closure Plan Update January 2017*. Submitted to Ministry of Energy and

Mines, March 15, 2017.

MPMC. (2017b). *Human Health Risk Assessment Technical Report*. Prepared by Golder Associates for Mount Polley. Submitted to the Ministry of Environment, May 11, 2017.

MPMC. (2017c). *Ecological Risk Assessment Technical Report*. Prepared by Golder Associates for Mount Polley. Submitted to the Ministry of Environment, December 15, 2017.

MPMC. (2017d). *Quality Assurance/Quality Control Manual*. Submitted to Ministry of Environment March 31, 2017.

MPMC. (2017e). *2016 Annual Environmental and Reclamation Report.* Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2017.

MPMC. (2018a). *2017 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2018.

MPMC. (2018b). *2018 Annual Discharge Plan*. Submitted to Ministry of Environment and Ministry of Energy and Mines, July 30, 2018.

Points West Heritage Consulting. (1989). *Heritage Resource Overview Assessment, Mount Polley Copper/Gold Project, Williams Lake, BC. Technical assessment submitted to MPMC*. Report submitted to Archeology and Outdoor Recreation Branch, October 10, 1989.

R Development Core Team. (2010). *R: a language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria.

Seametrics. (2016). *INW PT2x Pressure/Temperature Smart Sensor and Data Logger Instructions*. Seametrics, Kent Washington, USA.

SonTek. (2007). *FlowTracker Handheld ADV Technical Manual*. SonTek/YSI Inc, San Diego, California, USA.

SRK Consulting Inc. [SRK] (2015a). *Mount Polley Mine Tailings Dam Failure: Update on Geochemical Characterization of Spilled Tailings Technical Memorandum.* Prepared for and submitted to MPMC, November 2015.

SRK. (2015b). *Mount Polley Geochemical Characterization of Ore Stockpiles Technical Memorandum*. Prepared for and submitted to MPMC, October 2015.

SRK. (2016). *Derivation of Geochemical Source Terms, Mount Polley Mine Technical Memorandum*. Prepared for MPMC, September 2016.

Tetra Tech Inc. (2016). *Expected Plume Location by Month Technical Memorandum*. Prepared for MPMC, December 19, 2016.