BW GOLD LTD
a subsidiary company of Artemis Gold Inc

Blackwater Gold Project

Aquatic Effects Monitoring Program Plan

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The business of sustainability

ERM

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ACRONYMS AND ABBREVIATIONS

Aboriginal Groups or Indigenous nations	Aboriginal Groups include: Lhoosk'uz Dené Nation, Ulkatcho First Nation, Nadleh Whut'en First Nation, Stellat'en First Nation, Saik'uz First Nation and Nazko First Nation (as defined in the Project's Environmental Assessment Certificate #M19-01)
ADCP	Acoustic Doppler Current Profiler
AEMP	Aquatic Effects Monitoring Plan
Artemis	Artemis Gold Inc.
BACI	Before-after-control-impact
BC	British Columbia
BC MOE	BC Ministry of Environment
Project, the	Blackwater Gold Project
BW Gold	BW Gold LTD.
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CEA Agency	Canadian Environmental Assessment Agency
CEO	Chief Executive Officer
CFMP	Country Foods Monitoring Plan
CSFNs	Carrier Sekani First Nations
COO	Chief Operating Officer
CM	Construction Manager
CPUE	Catch per unit effort
CSM	Conceptual Site Model
°C	degrees Celsius
DOC	Dissolved organic carbon
DS	Decision Statement
EA	Environmental Assessment
EAC	Environmental Assessment Certificate
EAO	Environmental Assessment Office
ECD	Environmental Control Dam

ECCC	Environment and Climate Change Canada
EM	Environmental Manager
EMA	*Environmental Management Act*
EMC	Environmental Monitoring Committee
EMLI	Ministry of Energy, Mines and Low Carbon Innovation
EMS	Environmental Management System
ENV	BC Ministry of Environment and Climate Change Strategy
EPT	Ephemeroptera, Plecoptera, and Trichoptera
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations, and Rural Development
FSR	Forest Service Road
FWR	Freshwater Reservoir
GM	General Manager
IEM	Independent Environmental Monitor
Joint MA/EMA Application or Application	Joint Application for *Mines Act* and *Environmental Management Act* Permits Application
IFN	instream flow needs
ISQG	Interim Sediment Quality Guidelines
km	kilometre
KP	Knight Piésold
LDN	Lhoosk'uz Dené Nation
LGO	Low grade ore
LoM	Life of Mine
m	metre
MDL	method detection limit
MDMER	*Metal and Diamond Mining Effluent Regulations*
µS/cm	microsiemens per centimetre
mg/mL	milligrams per millilitre
MSDP	Mine Site Water and Discharge Monitoring and Management Plan

Mt	million tonnes
Mtpa	million tonnes per annum
MWLAP	Ministry of Water, Land and Air Protection
NTU	Nephelometric turbidity unit
PEL	Probable Effect Levels
POC	Parameter of concern
POPC	Parameter of potential concern
QA/QC	Quality Assurance and Quality Control
RCA	Reference Condition Approach
ROC	Receptor of concern
SBEB	Science-Based Environmental Benchmark
SCP	Sediment Control Pond
SQGs	sediment quality guidelines
t	tonne
TDS	Total dissolved solids
tpd	tonnes per day
TOC	Total organic carbon
TSF	Tailings Storage Facility
TSS	Total suspended solids
UFN	Ulkatcho First Nation
VP	Vice President
WBM	Water balance model
WMP	Water management pond
WQG-AL	Water quality guideline for the protection of aquatic life
WTP	Water treatment plant
YDWL	Yinka Dene Water Law

1. INTRODUCTION

The Blackwater Gold Project (the Project) is located approximately 112 kilometres (km) southwest of Vanderhoof, 160 km southwest of Prince George, and 446 km northeast of Vancouver (Figure 1-1), British Columbia (BC). The mine site is centered at latitude 53°11'22.872" N, and longitude 124°52'0.437" W (375400 E, 5893000 N) on National Topographic System sheet 93F/02.

The Project is a greenfield gold and silver open-pit mine with associated ore processing facilities. Project construction is anticipated to take two years. Mine operations will be phased with an initial milling capacity of 15,000 t/d or 5.5 million tones per annum (Mtpa) for the first five years of operation. After the first five years, the milling capacity will increase to 33,000 t/d (or 12 Mtpa) for the next five-years, and to 55,000 t/d (20 Mtpa) in Year +11 until the end of the 23-year mine life. The Closure phase is 24 to approximately 45 years, ending when the Open Pit has filled and the TSF is allowed to passively discharge to Davidson Creek, and the Post-closure phase is 46+ years. Ore will be processed in a plant by a combined gravity circuit and whole ore cyanide leach to recover gold and silver. The gold and silver will be recovered into a gold-silver doré product.

The mine site will cover an area of approximately 4,400 hectares to accommodate ore processing, the mine, mine waste, and on-site infrastructure (Figure 1-2). A tailings storage facility (TSF) has been designed to store tailings and potentially acid generating waste rock from the development of the open pit and ore processing (Figure 1-2). The TSF also includes a storage allowance for two supernatant ponds within each of the adjacent sites (TSF C and TSF D). Recoverable seepage from TSF C and TSF D and runoff from the Main Dam D will be collected into the interim Environmental Control Dam (ECD) or interim ECD and recycled back to the TSF (Figure 1-2). Surplus water from TSF C will be treated at a membrane water treatment plant (WTP) (for nitrogen, sulphate, and metals) prior to pumping to the water management pond (WMP). Seepage from TSF C not collected into the ECD contributes to groundwater that enters Davidson Creek and Creek 661 (Figure 1-2). Davidson Creek also receives TSF D seepage to groundwater (Figure 1-2).

Surplus non-acid generating waste rock and overburden from the Open Pit and not used in construction will be placed in the Lower and Upper waste stockpiles. Runoff and seepage from the waste stockpiles will be collected at the base of the stockpiles and directed to a collection pond where sediments are settled out. Water in the collection pond will be pumped to the Metals WTP; and treated water will be pumped to the WMP (Figure 1-2).

Runoff and infiltration from the low grade ore (LGO) stockpile will be collected and neutralized with lime (at the processing plant) to increase the pH and precipitate metals before gravity conveyance to the TSF (Figure 1-2). The Open Pit sump water (surface water that collects in the pit sump and groundwater from dewatering and depressurization wells) will be treated for metals and the treated water will be pumped for use in the mill or sent to the WMP (Figure 1-2).

The WMP is used to manage water released from the WTPs as well as non-contact surface runoff diverted from catchment area upslope of TSF C (Figure 1-2). The WMP provides make-up water to support ore processing at the mill, and water not required for mill operations will be pumped to the freshwater reservoir (FWR).

The FWR is an in-creek reservoir located immediately downstream of the ECD. The primary purpose of the FWR is to maintain environmental flows in Davidson Creek through a controlled release of water in construction through to closure. The FWR receives: 1) water pumped from the WMP, which constitutes both treated contact water and diverted non-contact water, 2) diverted non-contact water via the Central and Northern Diversion channels, and 3) water from Tatelkuz Lake via the freshwater supply pipeline later in operations (Figure 1-2). Thus, the FWR outlet is considered a final discharge location (point of compliance) for the Project at which permit and Metal and Diamond Mining Effluent Regulation (MDMER) limits will apply (see Appendix 9-E, Mine Site Water and Discharge Monitoring and Management Plan [MSDP]).

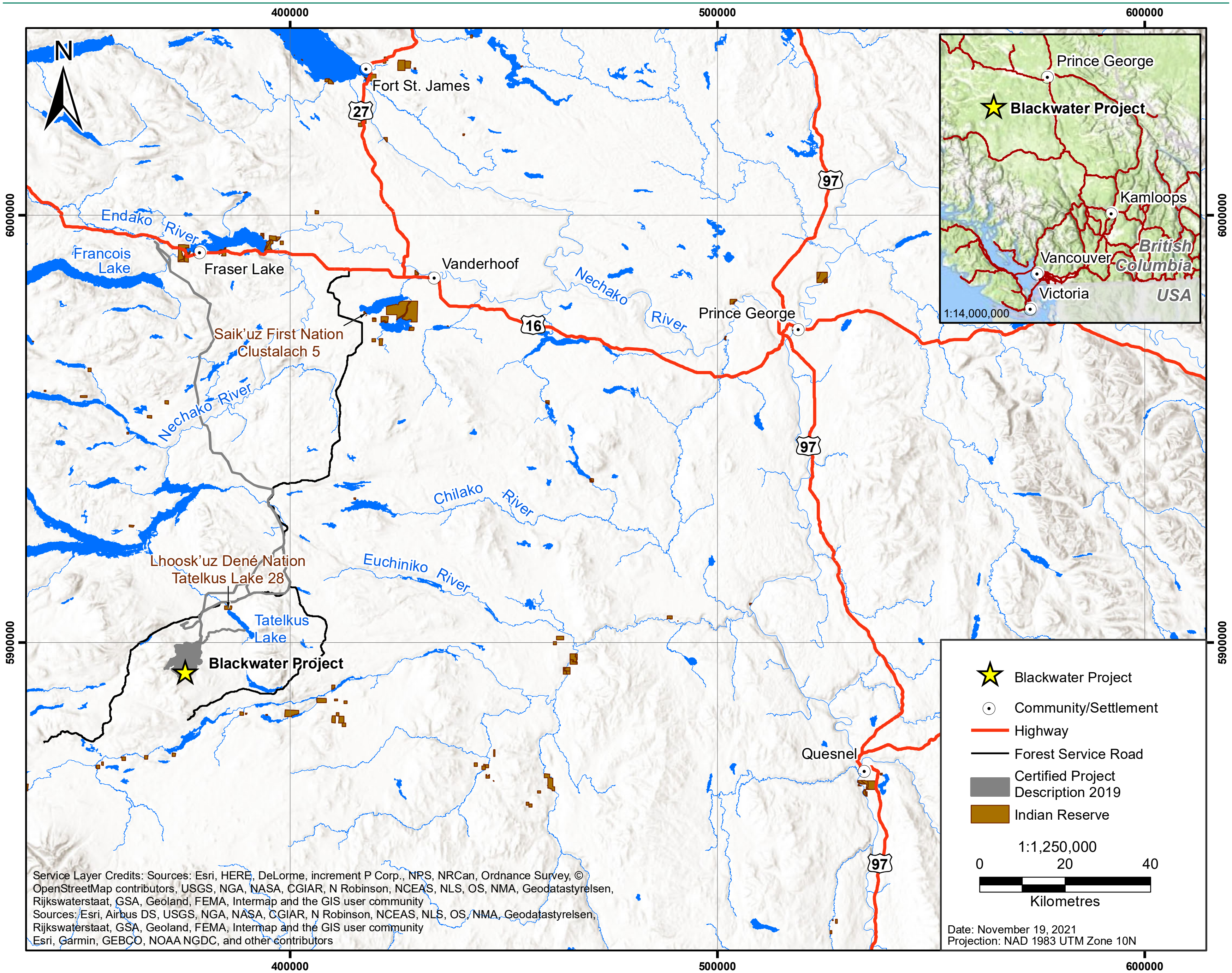

Figure 1-1: The Blackwater Gold Project Location

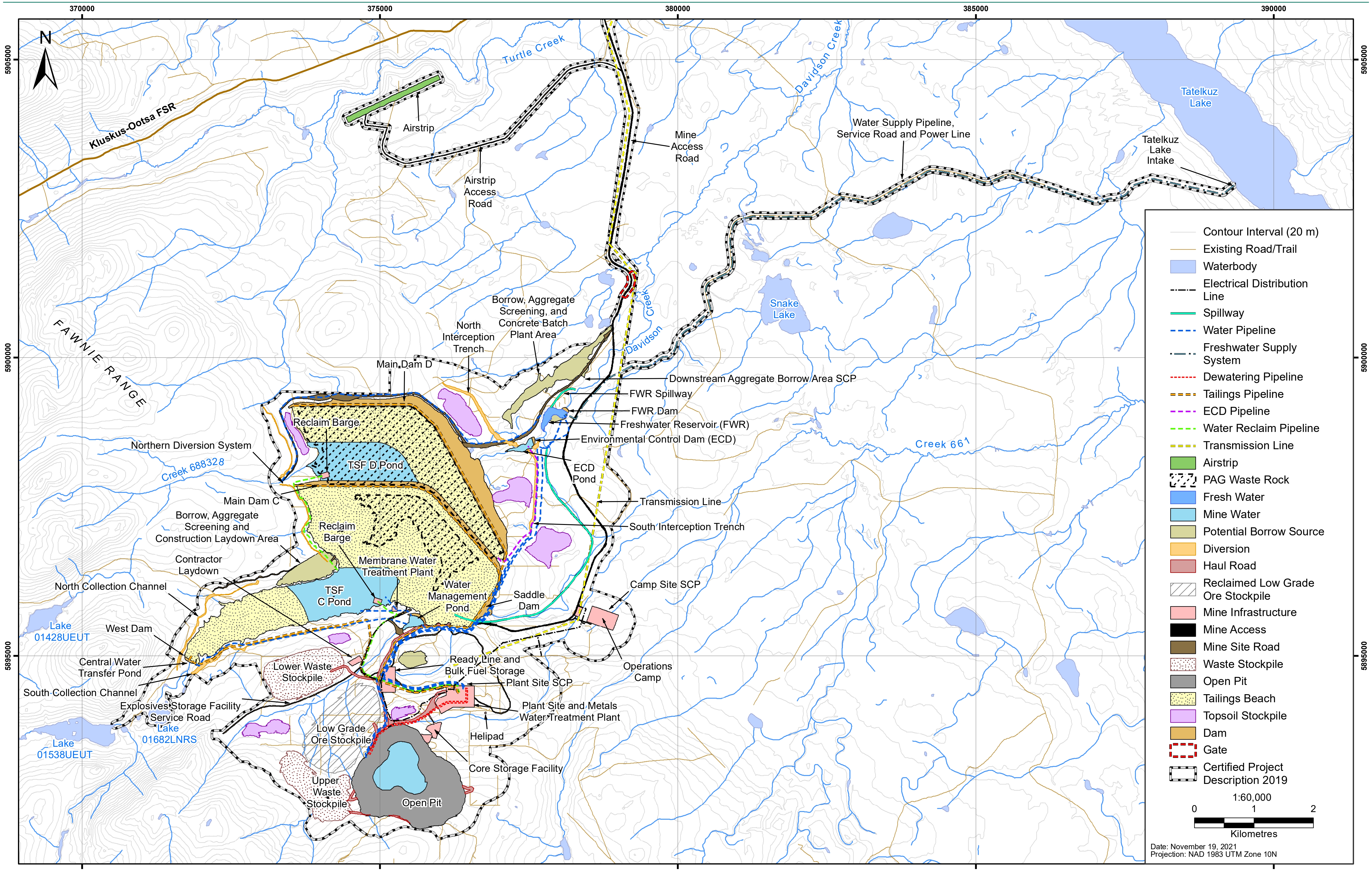

Figure 1-2: The Blackwater Gold Project Mine Plan

Surface water discharge will also occur from four sediment control ponds (SCPs): Plant Site SCP (Construction phase only), TSF Stage 1 SCP (Construction phase only), Downstream Aggregate Borrow Area SCP (Construction to Closure phase), and Camp Site SCP (Construction to Closure phase; see Appendix 9-E, MSDP). The Plant Site SCP will capture the infiltration water and discharge as surface water to Creek 661 during Construction phase. The TSF Stage 1 SCP will capture background surface runoff, background groundwater, and runoff from the Davidson Creek basin and Mine Area Creek basin, and discharge to Davidson Creek. Discharge from the Downstream Aggregate Borrow Area SCP will be directed to Davidson Creek. Discharge from the Camp Site SCP will be directed to the upper, unnamed tributary of Creek 661.

Creek 705 will receive diverted flows from the headwaters of Davidson Creek resulting in a predicted increase in flow of 10 L/s on an average annual basis at all locations on Creek 705. Creek 705 will not receive mine-contact water as surface water or as seepage to groundwater.

1.1 Purpose and Objectives

This Aquatic Effects Monitoring Program (AEMP) has been developed for aquatic receiving environment monitoring. The purpose of the AEMP is to provide information on the aquatic receiving environment necessary to achieve the following objectives:

- Detect Project-related effects on the aquatic ecosystem components (including water quality);
- Confirm water quality predictions and effects assessments, as presented in Chapter 5 (Modelling, Mitigation, and Discharges) and Chapter 6 (Environmental Assessment Predictions), respectively;
- Meet permit and regulatory requirements for effluent and receiving environment quality;
- Assess the performance of mitigation and management measures; and
- Provide the necessary feedback and information for the adaptive management of potential Project-related effects.

The AEMP addresses the requirements in Section 7.6 of the *Joint Application Information Requirements for Mines Act and Environmental Management Act Permits* (EMPR & ENV 2019). The focus of this AEMP is on Construction and Operations phases, because these are the phases where an effluent discharge authorization is being sought in the Application. A future permit amendment or a new authorization will be required for Closure and Post-closure phases, which will include an AEMP plan that may be a revised version of the plan described herein. However, to be conservative, it has been assumed that the AEMP described herein will continue into the Closure and Post-closure phases.

Monitoring surface water and groundwater flow and quality within the mine site (i.e., WMP or WTP effluent) or effluent at the end of pipe are not considered in the AEMP. The MSDP (Appendix 9-E) details the monitoring procedures for each phase of mine life for the effective interception, conveyance, diversion, storage, and discharge of water (contact and non contact) on the mine site. The MSDP (Appendix 9-E) also provides the operational and monitoring plans for all discharges of mine contact water to the receiving environment.

The AEMP addresses the Project's Environmental Assessment Certificate #M19-01 (EAC; EAO 2019) Conditions 30, 3 and 28. Attachment A provides the concordance tables where the EAC conditions are addressed in the AEMP. Attachment B provides the Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan in accordance with Condition 28. The objective this plan is to assess the surface water quality in Tatelkuz Lake and Chedakuz Creek upstream of the Nechako Reservoir to determine if there are any Project related effects. The monitoring plan has been developed as a stand-alone plan that can be incorporated into future iterations of the AEMP Plan given sampling locations, requirements, and reporting overlap with the AEMP.

The AEMP also addresses (whole or in part) the following conditions in the federal Decision Statement (DS; CEA Agency 2019): 3.8, 3.9, 3.14, 3.15, and 3.16; in addition to consultation conditions 2.3 and 2.4; follow-up and adaptive management conditions 2.5, 2.6, 2.7, 2.8, 2.9, and 2.10; and annual reporting conditions 2.11, 2.12, and 2.13. Attachment C provides a table of concordance indicating where the condition is addressed in the plan or will be addressed in a subsequent iteration of the AEMP Plan.

The AEMP is linked to Condition 41, Country Foods Monitoring Plan (CFMP), which identifies monitoring of the environment for human health objectives.

1.2 Roles and Responsibilities

BW Gold has the obligation of ensuring that all commitments are met and that all relevant obligations are made known to mine personnel and site contractors during all phases of the mine life. A clear understanding of the roles, responsibilities, and level of authority that employees and contractors have when working at the mine site is essential to meet Environmental Management System (EMS) objectives.

Table 1.2-1 provides an overview of general environmental management responsibilities during all phases of the mine life for key positions that will be involved in environmental management.
Other positions not specifically listed in Table 1.2-1 but who will provide supporting roles include independent environmental monitors, an Engineer of Record (EOR) for each tailings storage facility and dam, an Independent Tailings Review Board (ITRB), TSF qualified person, geochemistry qualified professional, and other qualified persons and qualified professionals.

Table 1.2-1: Blackwater Roles and Responsibilities

Role	Responsibility
Chief Executive Officer (CEO)	The CEO is responsible for overall Project governance. Reports to the Board.
Chief Operating Officer (COO)	The COO is responsible for engineering and Project development and coordinates with the Mine Manager to ensure overall Project objectives are being managed. Reports to CEO.
Vice President (VP) Environment & Social Responsibility	The VP of Environment & Social Responsibility is responsible for championing the Environmental Policy Statement and EMS, establishing environmental performance targets and overseeing permitting. Reports to COO.
General Manager (GM) Development	The GM is responsible for managing project permitting, the Project’s administration services and external entities, and delivering systems and programs that ensure Artemis’s values are embraced and supported, Putting People First, Outstanding Corporate Citizenship, High Performance Culture and Rigorous Project Management and Financial Discipline. Reports to COO.
Mine Manager	The Mine Manager, as defined in the *Mines Act*, has overall responsibility for mine operations, including the health and safety of workers and the public, EMS implementation, overall environmental performance and protection, and permit compliance. The Mine Manager may delegate some of their responsibilities to other qualified personnel. Reports to GM.
Construction Manager (CM)	The CM is accountable for ensuring environmental and regulatory commitments/ and obligations are being met during the construction phase. Reports to GM.
Environmental Manager (EM)	The EM is responsible for the day-to-day management of the Project’s environmental programs and compliance with environmental permits, updating EMS and MPs. The EM or designate will be responsible for reporting non-compliance to the CM, and Engineering, Procurement and Construction Management (EPCM)

Role	Responsibility
	contractor, other contractors, the Company and regulatory agencies, where required. Supports the CM and reports to Mine Manager.
Departmental Managers	Departmental Managers are responsible for implementation of the EMS relevant to their areas. Report to Mine Manager.
Indigenous Relations Manager	Indigenous Relations Manager is responsible for Indigenous engagement throughout the life of mine. Also responsible for day-to-day management and communications with Indigenous groups. Reports to VP Environment & Social Responsibility.
Community Relations Advisor	Community Relations Advisor is responsible for managing the Community Liaison Committee and Community Feedback Mechanism. Reports to Indigenous Relations Manager.
Environmental Monitors	Environmental Monitors (includes Environmental Specialists and Technicians) are responsible for tracking and reporting on environmental permit obligations through field-based monitoring programs. Report to EM.
Aboriginal Monitors	Aboriginal Monitors are required under EAC condition 17 and will be responsible for monitoring for potential effects from the Project on the Indigenous interests. Indigenous Monitors will be involved in the adaptive management and follow-up monitoring programs. Report to EM.
Employees and Contractors	Employees are responsible for being aware of permit requirements specific to their roles and responsibilities. Report to Departmental Managers.
Qualified Professionals and Qualified Persons	Qualified professionals and qualified persons will be retained to review objectives and conduct various aspects of environmental and social monitoring as specified in EMPs and social MPs.

BW Gold will employ a qualified person as an EM who will ensure that the EMS requirements are established, implemented and maintained, and that environmental performance is reported to management for review and action. The EM is responsible for retaining the services of qualified persons or qualified professionals with specific scientific or engineering expertise to provide direction and management advice in their areas of specialization. The EM will be supported by a staff of Environmental Monitors that will include Environmental Specialists and Technicians and by a consulting team of subject matter experts in the fields of environmental science and engineering.

During the Construction phase, BW Gold will be entering into multiple EPC contracts, likely for the Transmission Line, Process Plant, Tailings and Reclaim System, and 25 kV Power Distribution. Each engineer/contractor will have their own CM and there will be a BW Gold responsible PM and/or Superintendent who ultimately reports to the GM Development. Some of the scope, such as the TSF and Water Management Structures will be self-performed by BW Gold, likely using hired equipment. Other smaller scope packages may be in the form of EPCM contracts. The EPCM contractors will report to the CMs who will ultimately be responsible for ensuring that impacts are minimized, and environmental obligations are met during the Construction phase. For non-EPCM contractors, who will perform some of the minor works on site, the same reporting structure, requirements, and responsibilities will be established as outlined above. BW Gold will maintain overall responsibility for management of the construction and operation of the mine site and will therefore be responsible for establishing employment and contract agreements, communicating environmental requirements, and conducting periodic reviews of performance against stated requirements.

The CM is accountable for ensuring that environmental and regulatory commitments/obligations are being met during the construction phase. The EM will be responsible for ensuring that construction activities are proceeding in accordance with the objectives of the EMS and associated MPs. The EM or designate will be responsible for reporting non-compliance to the CM and EPCM contractor, other contractors, and regulatory agencies, where required. The EM or designate will have the authority to stop any construction activity that is deemed to pose a risk to the environment; work will only proceed when the identified risk and concern have been addressed and rectified.

Environmental management during operation of the Project will be integrated under the direction of the EM, who will liaise closely with departmental managers and will report directly to the Mine Manager. The EM will be supported by the VP of Environment and Social Responsibility in order to provide an effective and integrated approach to environmental management and ensure adherence to corporate environmental standards. The EM will be accountable for implementing the approved MPs and reviewing them periodically for effectiveness. Departmental area managers (e.g., mining, milling, and plant/site services) will be directly responsible for implementation of the EMS and EMPs relevant to their areas. All employees and contractors are responsible for daily implementation of the practices and policies contained in the EMS.

Pursuant to Condition 19 of the Project's EAC #M19-01, BW Gold has established an Environmental Monitoring Committee to facilitate information sharing and provide advice on the development and operation of the Project, and the implementation of EAC conditions, in a coordinated and collaborative manner. Committee members include representatives of the Environmental Assessment Office (EAO), Ulkatcho First Nation (UFN), Lhoosk'uz Dené Nation (LDN), Nadleh Whut'en First Nation, Saik'uz First Nation (SFN), and Stellat'en First Nation, as well as the traditional territories of the Nazko First Nation, Ministry of Energy, Mines and Low Carbon Innovation (EMLI), Ministry of Environment and Climate Change Strategy (ENV), and Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD).

Pursuant to Condition 17 of the EAC, Aboriginal Group Monitor and Monitoring Plan, BW Gold will retain or provide funding to retain a monitor for each Aboriginal Group prior to commencing construction and through all phases of the mine life. The general scope of the monitor's activities will be related to monitoring for potential effects from the Project on the Aboriginal Group's Aboriginal interests.

1.3 Compliance Obligations, Guidelines, and Best Management Practices

1.3.1 Legislation

Federal legislation applicable to the AEMP:

- *Canadian Environmental Protection Act, 1999*;
- *Fisheries Act*;
    - *Metal and Diamond Mining Effluent Regulations*;
- *Impact Assessment Act*;
- *Species at Risk Act*; and
- *United Nations Declaration on the Rights of Indigenous Peoples Act.*

Provincial legislation applicable to the AEMP:

- *Declaration on the Rights of Indigenous Peoples Act;*
- *Drinking Water Protection Act;*
- *Environmental Assessment Act*;
- *Environmental Management Act*;

  - Environmental Data Quality Assurance Regulation;
  - Waste Discharge Regulation;
- *Mines Act;*
  - *Health, Safety and Reclamation Code for Mines in BC*; and
- *Water Sustainability Act.*

In addition to considering EAC Condition 30 (see Section 1.1) and the typical monitoring required under *Environmental Management Act* (EMA) discharge authorizations for mines, the AEMP has been designed to incorporate MDMER requirements for the receiving environment required for the Environmental Effects Monitoring program (Schedule 5 of the MDMER).

1.3.2 Existing Permits

BW Gold has received a permit for an effluent discharge authorization (PE-110602) for discharge of treated stormwater effluent to ground during early stage construction activities, including monitoring requirements. This discharge of treated stormwater effluent during early stage construction activities is authorized separately than the effluent discharges anticipated during Construction and Operations phases of the Project (i.e., the subject of the Application) and the discharge is to ground and not to a watercourse therefore it is not discussed further in this AEMP. The requirements outlined in this AEMP will supersede or replace the requirements of the existing early works permit (PE-110602) once a discharge authorization for Construction and Operations phases has been issued.

1.3.3 Guidelines and Best Management Practices

Federal, provincial, and regional guidance documents inform the monitoring practices in the AEMP. Several of these documents are referenced in the EAC and are referenced in this plan. Key guidance documents include:

- *British Columbia Environmental Laboratory Manual* (BC ENV 2020a);
- *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (BC MOE 2016a);
- *British Columbia Field Sampling Manual* (BC MWLAP 2013);
- *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report* (BC ENV 2019);
- *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (BC ENV 2021);
- *Manual of British Columbia Hydrometric Standards, Version 2.0* (RISC 2018);
- *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (RIC 2001);
- *Metal Mining Technical Guidance Document for Environmental Effects Monitoring* (Environment Canada 2012);
- Canadian Council of Ministers of the Environment (CCME) *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2021a);
- CCME *Sediment Quality Guidelines for the Protection of Aquatic Life* (CCME 2021b);
- *Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota: Methylmercury* (CCME 2000); and
- *Canadian Aquatic Biomonitoring Network: Field Manual for Wadeable Streams* (CABIN) protocols (Environment Canada 2012).

The AEMP also takes into consideration the Yinka Dene Water Law (YDWL) as required by EAC Condition 30 and is described in the following documents:

- *Yinka Dene 'Uza'hné Surface Water Management Policy* (Nadleh Whut'en and Stellat'en 2016a); and
- *Yinka Dene 'Uza'hné Guide to Surface Water Quality Standards* (Nadleh Whut'en and Stellat'en 2016b).

BW Gold has been collaborating with the Carrier Sekani First Nations (CSFNs) regarding the implementation of the YDWL, and discussions with the CSFNs are ongoing. The YDWL describes a system that classifies waters into three categories based on their cultural and ecological significance, including:

- High Cultural or Ecological Significance (Class I Waters);
- Sensitive Waters (Class II Waters); and
- Typical Waters (Class III Waters).

Baseline characterization requirements for implementation of the *Yinka Dene 'Uza'hné Surface Water Management Policy* (Nadleh Whut'en and Stellat'en 2016a) include sampling frequency recommendations provided by CSFNs representatives (Appendix 2-K, 2011 to 2020 Baseline Water Quality Report). Site-specific comparison of predicted water quality data with water quality standards calculated using the YDWL guidance was also completed for one sampling location in Chedakuz Creek in the 2011 to 2020 Baseline Water Quality Report (Appendix 2-K) as required by Condition 27 of the EAC.

1.4 Components Included in the Aquatic Effects Monitoring Program

The following components of the aquatic ecosystem will be monitored as part of the AEMP:

- Surface water quantity, quality, and toxicity testing;
- Sediment chemistry and toxicity testing;
- Aquatic primary producers;
- Aquatic benthic invertebrates;
- Fish community; and
- Water-dependent wildlife.

1.5 Conceptual Site Model

As part of the Application, a stand-alone conceptual site model (CSM) report was prepared that consists of a problem formulation, which culminates in a graphic presentation of the Project-related sources, transport pathways, and exposure pathways for parameters of concern (POC) to the different types of receptors of concern (ROCs) that may be found at or near the Project (originally appended to the Application as Appendix 5-I, also reproduced as Appendix 7-B, Conceptual Site Model Report). A summary of the CSM specific to the relationship of mining-related activities and potential effects on the aquatic environment is presented below.

1.5.1 Types, Sources, and Transport Pathways for Parameters of Concern in the Aquatic Environment

The CSM identified parameters of potential concern (POPCs), following guidance from BC ENV (2019b), as all parameters with baseline or predicted concentrations exceeding or approaching an applicable water quality guideline (i.e., concentrations of more than 80% of the applicable guideline). A POC was then identified from the POPC list as a parameter that had, as a result of the Project, a predicted concentration higher than an applicable water quality guideline for a receptor of concern and higher than the range of existing concentrations.

Parameters of potential concern for the Project included various water constituents such as metals, anions, and nutrients (nitrogen forms and phosphorus). When concentrations of these parameters are higher than the water quality guideline for protection of aquatic life (WQG-AL) there is potential for adverse effects to aquatic biota (e.g., mortality or impairment of growth and reproduction) which can lead to changes in abundance, distribution, or community structure of primary producers, benthic invertebrates, and fish.

Project infrastructure such as the Open Pit and dewatering system, TSF, waste and LGO stockpiles, water management infrastructure, haulage and service roads, and mining activities such as milling, equipment use, and blasting, were considered sources of Project-related POCs. Anions, metals, and nitrogen-containing compounds from these components can be transported to the receiving environment outside of the mine site through either effluent discharge or seepage, as described in the surface water quality model (Section 5.4 of Chapter 5 [Modelling, Mitigation, and Discharge]) and the groundwater model (Section 5.5 of Chapter 5 [Modelling, Mitigation, and Discharge]).

Specific ROCs were identified for the Project based on their expected or confirmed presence in the area, water uses, land uses, and species identified as receptor components (RCs) in Chapter 6 (Environmental Assessment Predictions). Aquatic life receptors included periphyton, benthic invertebrates, and fish. Specific water-dependent wildlife receptors included amphibians and water birds, although all wildlife ROCs were assumed to have the potential to drink surface water.

The ways in which the ROCs could be exposed to Project-related POCs was identified based on whether potential exposure pathways were operable, operable but insignificant (and not considered further), or not operable. The following exposure pathways were identified as being operable for further consideration:

- Aquatic Life ROCs: direct contact with water and/or sediment, uptake from diet; and
- Wildlife ROCs: ingestion of soil, food, or water.

Identification of POCs considered relevant exposure media for each receptor group and conservatively compared the 95th percentile (base case water quality predictions) of a parameter in Baseline Case (pre-development measured concentrations) and Project Case (concentrations predicted in Construction and Operations phases) to applicable guidelines in each media.

The POCs identified in the CSM report (Appendix 5-I and Appendix 7-B) were carried forward to the residual effects assessment in Chapter 6 (Effects Assessment). Residual effects associated with the predicted concentrations of POCs were subsequently characterized using standard criteria (including magnitude, spatial extent, and duration) and standard ratings (e.g., minor/low, medium, and high).

1.5.2 Conceptual Site Model Results

When concentrations of parameters are higher than the water quality guideline for protection of aquatic life (WQG-AL) there is potential for adverse effects to aquatic biota (e.g., mortality or impairment of growth and reproduction) which can lead to changes in abundance, distribution, or community structure of primary producers, benthic invertebrates, and fish.

For Aquatic Life ROCs, dissolved aluminum was identified as a POC because predicted concentrations were higher than the WQG-AL and were higher than the range of existing concentrations at one modelling node (WQ9 in Chedakuz Creek) during one month of Construction phase. High concentrations of aluminum can result in mortality and changes in growth or reproduction of aquatic biota. However, given that the predicted concentrations of dissolved aluminum are within the range of background concentrations to which resident aquatic biota have adapted, Project-related effects to aquatic biota were not predicted to occur.

Nitrogen forms (nitrate, nitrite, and ammonia) and total phosphorus were identified as “special case” POCs to be assessed in Chapter 6 (Effects Assessment Predictions) for aquatic resources, because changes in concentrations of these parameters, even at levels lower than the WQG-AL, can cause nutrient enrichment or eutrophication; this, in turn, can cause changes in primary producer abundance or community structure.

Although there is no WQG-AL, total dissolved solids (TDS) was also carried forward as a special case POC, based on interest expressed by ENV and best professional judgement. High TDS concentrations can cause osmoregulatory stress in aquatic biota which can affect biota abundance or community structure through impacts on growth, reproduction or survival.

The problem formulation for the CSM was summarized in a series of figures representing the Project-related sources, transport pathways, exposure pathways, and receptors for Baseline Case and Project Case (Attachment B of Appendix 7-B, Conceptual Site Model Report). The POCs identified in the CSM report (Appendix 7-B) were carried forward to the residual effects assessment in Chapter 6 (Effects Assessment). Residual effects associated with the predicted concentrations of POCs were subsequently characterized using standard criteria (including magnitude, spatial extent, and duration) and standard ratings (e.g., minor/low, medium, and high).

1.5.3 Conceptual Site Model Uncertainties

Several uncertainties related to the aquatic environment were identified in the CSM and additional monitoring was recommended to address those uncertainties. This included:

- Collecting surface water samples for chromium speciation analysis. This additional monitoring is currently underway at a subset of water quality sampling sites in Davidson Creek (2 sites), Creek 661 (1 site), Chedakuz Creek (1 site), and Tatelkuz Lake (1 site) quarterly for a one-year period. This monitoring was recommended and implemented immediately (Q3 2021) to address uncertainty because the total chromium concentration when compared to the most conservative chromium WQG-AL (i.e., hexavalent chromium (Cr[VI])), sporadically exceeded the WQG-AL for Cr(VI) in baseline sampling. However, it is not known what proportion of the total chromium is in the Cr(VI) form. The sampling currently underway for chromium speciation of water samples will be evaluated after one year of data collection to determine whether chromium speciation analysis should be continued (it is not currently included in the AEMP). If the proportion of Cr(VI) out of total chromium is low or Cr(VI) concentrations are undetectable or below the WQG-AL for Cr(VI), chromium speciation sampling would not be recommended for inclusion in the AEMP as a routine analysis in the future.
- Co-collecting surface water and fish tissue samples for mercury analysis during Construction and Operations phases. This recommendation was made because the surface water quality model predicted an increase in surface water concentrations for mercury, which then led to a predicted increase in fish tissue concentrations. However, the increased concentrations predicted by the surface water quality model are due to detection limits higher than the WQG-AL for mercury in some of the geochemistry source terms and are expected to be overestimates of the actual future concentrations. Thus, monitoring of mercury in both surface water and fish tissue was recommended to confirm whether mercury concentrations change as a result of the Project. This recommendation is incorporated into the future monitoring described in the AEMP for water (Section 4.4.2) and fish tissue (Section 4.8.1).

2. ENGAGEMENT AND CONSULTATION

BW Gold has completed some engagement and consultation on the AEMP plan with Indigenous nations, and have planned additional engagement and consultation. Activities to date are described in Section 2.1, future engagement and consultation on this draft AEMP plan during the period prior to Application submission and Application review is described in Section 2.2, and future opportunities are described in Section 2.3 for engagement and consultation on the final AEMP Plan, Version 1.0.

2.1 Engagement and Consultation Prior to Availability of a Draft Aquatic Effects Monitoring Program Plan

During the preparation of the Application and this draft AEMP plan, and prior to the completion of the draft plan, BW Gold engaged with UFN and LDN as part of the regular Blackwater Environmental Monitoring Board meetings to discuss the proposed sampling plans for the AEMP during meetings to discuss the Country Foods Monitoring Plan (required by EAC Condition 41). There is significant overlap between the AEMP and the CFMP, particularly related to water quality and fish tissue sampling. The first discussion on May 5, 2021 included a presentation of the preliminary plans for sampling under the AEMP and CFMP, during which UFN, LDN, and their consultants were invited to provide input and feedback on the preliminary proposed sampling plans.

Draft comments were provided by UFN and LDN to BW Gold in an Excel tracking spreadsheet in early June 2021. Although the comments were focused on aquatic sampling in the context of the CFMP, several comments were relevant to the AEMP proposed sampling plan related to sampling frequency (annually versus every three years), sampling locations (lakes versus streams), and type of sampling (adult versus juvenile fish). As a result of the input and feedback received from the UFN and LDN, the proposed sampling plan for both the AEMP and CFMP was revised to include:

- Sampling frequency is proposed to be set to annually, initially (rather than every three years), with a framework to decrease sampling frequency if effects were not identified and a minimum sampling frequency of once every three years.
- Sampling of fish tissue from adult fish (kokanee, rainbow trout, and whitefish) from Tatelkuz Lake and Kuyakuz Lake (reference site) were added to the sampling plan, rather than focusing only on rainbow trout in the stream sites closest to the mine site. Sampling of fish tissue from locations where there is kokanee spawning habitat (e.g., lower Davidson Creek, Chedakuz Creek) is not recommended to ensure that this important fish habitat is not altered or damaged by methods requiring in-creek sampling.

The revised AEMP and CFMP sampling plans were presented and discussed at a meeting on July 29, 2021 and no comments specific to the AEMP plan or requiring changes to the revised plans were received.

Indigenous nations have also provided comments on the Draft Information Requirements Table for *Mines Act/Environmental Management Act* permits application issued by EMLI and the Initial Project Description. Comments specific to the AEMP provided by the CSFNs, UFN, and LDN on April 16, 2021. Draft responses were provided by BW Gold late July 2021 and BW Gold met with groups August 19, 2021 to discuss comments.

2.2 Engagement and Consultation on Draft Aquatic Effects Monitoring Program Plan Prior to Application Submission and during Application Review

BW Gold provided this draft AEMP plan to the Indigenous nations for review in advance of the Application submission. The plan has been revised to address the comments.

Once the Application, including the draft AEMP plan, has been submitted, it is expected that Indigenous nations, regulators, and others will review the AEMP and provide comments. BW Gold intends to receive, consider, and respond to all comments received from reviewers. The responses to comments may include providing additional rationale or explanations or making changes to the draft AEMP. At the completion of the Application review, an AEMP Plan, Version 1.0 will be completed and issued that incorporates all changes made to the AEMP during the Application review and is compliant with the requirements for environmental monitoring that will ultimately be defined in the effluent discharge authorization issued by the ENV.

2.3 Future Engagement and Consultation on the Final Aquatic Effects Monitoring Program Plan

The AEMP Plan, Version 1.0 will be the starting point for future monitoring of the aquatic environment outside of the mine site. It is expected that the plan will be reviewed and revised, as required, on a regular basis to ensure that the objectives described in Section 1.1 are achieved. Future revisions to the AEMP plan may include adjusting, adding, or removing monitoring components to ensure that the objectives are achieved, to reflect changes/updates to field practices or guidance, and to address uncertainties identified in either the Application or future monitoring.

Future engagement and consultation will be conducted in accordance with DS Condition 2.3 and Condition 2.4 (see Attachment C).

The typical reporting requirement under effluent discharge authorizations for most mining projects are that compliance reports to be submitted by March 31 of the year following the reporting period (e.g., by March 31, 2023 for data collected in the 2022 calendar year). It is anticipated that the AEMP will be reviewed as part of each reporting cycle (i.e., each time an AEMP report is issued). The qualified professional preparing the AEMP report will document proponent-identified recommendations for changes to the AEMP.

In addition, submission of recommendations, input, or feedback from Indigenous nations or regulators to BW Gold are also anticipated following review of the AEMP report after each AEMP reporting cycle. BW Gold intends to track and respond to comments received on the AEMP report, which may include proposing changes to the AEMP sampling plan or analysis. The process and timelines for review of future AEMP reports and changes to the AEMP itself will be defined through engagement and consultation with Indigenous nations during the draft AEMP plan review and Application review, in addition to additional permit requirements documented in the future discharge authorization; thus, details are not provided yet in this draft AEMP plan.

Separate from the AEMP, EAC Condition 12 requires an Independent Environmental Monitor (IEM) be retained by the proponent during all phases of the Project. This is in addition to EAC Condition 17 that requires an Aboriginal Group Monitor and Monitoring plan, where the proponent must retain or provide funding to retain one monitor for each Aboriginal Group. It is possible that the IEM or monitor retained under EAC Condition 17 could identify and recommend additional sampling be incorporated into the AEMP rather than under a separate monitoring program. BW Gold would consider and respond to any input or comments received from the IEM or Aboriginal Group monitor as it relates to the AEMP.

Upon approval of the AEMP Plan, Version 1.0, future changes to the AEMP will require robust review to ensure that the AEMP will continue to meet regulatory requirements (e.g., elimination of a monitoring component required by the EAC or effluent discharge authorization cannot be completed without an amendment authorizing the removal). Changes to the AEMP could also affect the ability to conduct some statistical analyses (e.g., before-after-impact-control) that rely on collecting similar or analogous data over time at the same locations. To the extent possible, BW Gold intends to engage in consensus-based decisions with Indigenous nations and regulators regarding changes to the scope, methods, and analysis used in the AEMP, while maintaining regulatory compliance.

3. OVERVIEW OF EXISTING CONDITIONS, ISSUES, AND CONCERNS IN THE AQUATIC ENVIRONMENT

While an overview of existing conditions, issues, and concerns is not usually included in an AEMP plan, EAC Condition 30(d) requires this information to be provided here. The following subsections provide a high-level overview of this information.

Since the effects assessment for the Project found that adverse effects to biota in the receiving environment are not predicted to occur, there are no "known effects to local biota or related species from POCs" to describe in the AEMP as Project effects on biota are not expected to be different from baseline conditions. The baseline characterization provided in the following subsections for aquatic primary producers (Section 3.3), aquatic invertebrates (Section 3.4), fish and fish habitat (Section 3.5), and water-dependent wildlife (Section 3.6) would be representative of the known effects to local biota or related species from POCs under both baseline and future Project conditions.

3.1 Existing and Predicted Conditions for Hydrology and Water Quality

3.1.1 Hydrology and Water Temperature

3.1.1.1 Baseline

A detailed summary of the hydrology baseline data collected for the Project is provided in Section 2.6 of Chapter 2 (Existing Conditions) and associated appendices (Appendix 2-B, 2020 Hydrometeorology Report and 2-I, 2020 Hydrology and Water Temperature Baseline Report). Hydrologic characterization (e.g., rating curves, discharge hydrographs, and water temperature) of watercourses downstream of the Project (and of reference sites) has been conducted on an annual basis between 2011 and 2020. Monitoring includes lake level monitoring stations and streamflow stations to capture the hydrologic trends of five major catchments (Figure 3.1-1):

1. The Davidson Creek catchment (4 stations)
2. The Turtle Creek catchment (1 station)
3. The Creek 661, and Tatelkuz Lake catchments (3 stations)
4. Chedakuz Creek catchment (1 station)
5. The Fawnie Creek catchment (2 stations)

Typical hydrologic trends based on watershed size and elevation indicate that stations with higher elevations and smaller catchments tend to experience higher unit runoff during freshet, and lower unit runoff during the summer, while stations directly downstream of a lake show runoff attenuation related to the storage capacity of the upstream lake. Data from the Project hydrological stations indicated that peak streamflow occur in May, with low flows in August and September as well as November through March (Appendix 2-B, 2020 Hydrometeorology Report).

The estimated level for Tatelkuz Lake over a 40-year period is approximately 927.03 masl for the annual average and 926.91 masl for a 1-in-50-year dry event. Long-term analysis suggests that Tatelkuz Lake levels are the lowest in September and highest in May during freshet. Results of a bathymetric survey indicated that the point of zero flow from the Tatelkuz Lake outlet was estimated to be 926.48 masl, with the water depth at the lake outlet at the time of the bathymetric survey estimated to be 1.12 m and the outflow to Chedakuz Creek to be about 7.13 cubic metres per second (KP 2013).

Water temperature of the Project area creeks is monitored at hydrology stations. The results indicate that creeks are typically characterized by near freezing temperatures prior to spring freshet, followed by a gradual warming period until July and August, which are the warmest months at between 10 ºC and 14 ºC (Appendix 2-I, 2020 Hydrology and Water Temperature Baseline Report). Temperatures then decrease steadily back to near freezing temperatures by November or December.

Within Davidson Creek, water temperatures at the lower elevation stations are consistently and progressively warmer than at the higher elevation stations throughout freshet, summer, and fall. Water temperatures in Tatelkuz Lake were greater than the temperatures at the downstream Chedakuz Creek station. A temperature difference ranging from -0.9 ºC to 13.0 ºC, (average of 2.1 ºC) was observed between the Tatelkuz Lake outlet and downstream. This difference is likely largely due to the cooling effect of groundwater discharge into the stream as flows travelled downstream in Chedakuz Creek.

3.1.1.2 Site-wide Water Balance Model

A life of mine water balance model (LoM WBM) was developed for the Project to estimate surface water and groundwater flows through the life of the mine (see Section 5.3, of Chapter 5 [Modelling, Mitigation, and Discharges] and Appendix 5-B, Life of Mine Water Balance Model Report). The LoM WBM simulates water management flows, surface water, and groundwater flows using one continuous model that is built out through the entire life cycle of the mine. Climate inputs to the LoM WBM include mean monthly climate averaged over years 1980 through 2020.

Activities during the life cycle of the Project are predicted to influence streamflows in Davidson Creek, Creek 661, Turtle Creek, and Chedakuz Creek. Flows in Davidson Creek are predicted to decrease through Construction and Operations phases. The LoM WBM predicted that flows will be less than baseline in Creek 661 in all phases as a result of the development of the Open Pit. Flows in Chedakuz Creek are predicted to decrease through Operations phase relative to baseline observations. Flows in Creek 705 are predicted to increase beginning during Construction after a portion of the Davidson Creek headwaters is diverted to Creek 705 and the increased flow are expected to persist through all phases.

3.1.2 Surface Water Quality

3.1.2.1 Baseline

Spatial and temporal background (baseline) water quality data within the vicinity of the Project have been collected since 2011 (Appendix 2-K, 2011 to 2020 Baseline Water Quality Report). The baseline surface water quality program collected samples from streams and lakes that could potentially be affected by the Project (e.g., Davidson Creek, Creek 661, Turtle Creek, Chedakuz Creek, Tatelkuz Lake) in addition to reference locations (Figure 3.1-1). Water quality site names have been updated since completion of baseline sampling to reflect the creek/lake name (Attachment D).

Sampling frequency in lakes and streams has ranged from quarterly to monthly, with some additional targeted sampling weekly (weekly samples for five weeks) during freshet (May/June) and summer low flow (August/September). Baseline characterization has also been completed for the purpose of the *Yinka Dene ‘Uza’hné Surface Water Management Policy* (Nadleh Whut’en and Stellat’en 2016a) to provide the foundation for monitoring of potential attainment sites in Tatelkuz Lake, Davidson Creek and Chedakuz Creek. Monthly with weekly (5-in-30-day) sampling in May/June and August/September were carried out at potential YDWL attainment sites beginning in 2019 and continued in 2021 and 2022 to meet the requirements in the YDWL (Appendix 2-K, 2011 to 2020 Baseline Water Quality Report). Baseline water quality was compared to 2020 BC (BC ENV 2019a, 2020b) or 2020 federal (CCME 2020) water WQG-AL (provided in Attachment E) with the results summarized below.

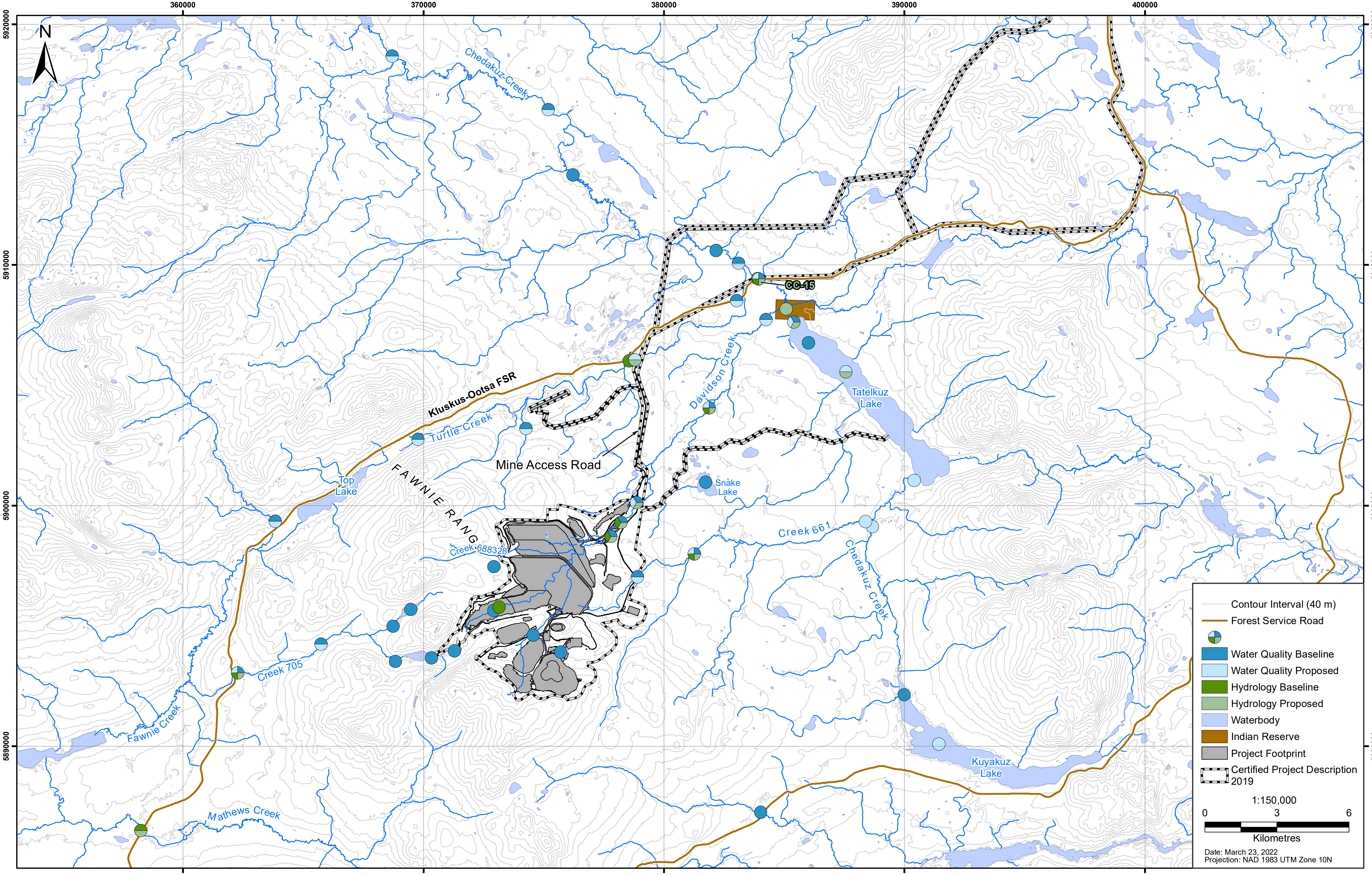

Figure 3.1-1: Baseline and Proposed Sampling Locations for Hydrology and Surface Water Quality

Concentrations of most water quality parameters in the monitored streams were generally driven geographically and seasonally controlled (i.e., typically highest during low flow periods and reduced during freshet). Water in the monitored streams was near-neutral to slightly alkaline in pH, with hardness characterized as typically soft to moderately hard. Total suspended solids (TSS) and turbidity were generally low in Project streams, except during periods of increased runoff in freshet and during fall rains. Organic carbon concentrations were high at all sampled locations, which were predominantly observed as dissolved organic carbon (DOC).

Seasonal variability was observed in nitrate and nitrite concentrations; higher concentrations of both were typically observed during winter months. Ammonia concentrations were frequently below the method detection limit (MDL), particularly during winter months. Total phosphorus concentrations varied intra-annually and were typically highest in April and May. Generally total phosphorus concentrations at stream sites were in the oligotrophic to mesotrophic range of values, with the exception of a Creek 661 station where mean values were above the trigger value for eutrophic conditions (0.035 mg/L).

Concentrations of major anions (chloride, fluoride, and sulphate) were low in Project streams and did not exceed BC WQGs in any of the collected stream samples. Total metals were frequently dominated by the dissolved form, and consequently followed similar temporal and spatial patterns to TDS, with lower concentrations during periods of increased flow. The primary exception was aluminum. Total and dissolved aluminum were both elevated across multiple sites and regularly were higher than WQG-AL; aluminum concentration trends generally followed the same pattern as TSS.

Parameters with concentrations higher than BC or CCME WQG-AL in the majority of the monitored streams were total and dissolved aluminum, total and dissolved cadmium, total chromium, total and dissolved copper, total and dissolved iron, and total and dissolved zinc. Other parameters occasionally measured to be above WQG-AL were nitrite, total arsenic, dissolved cadmium, total and dissolved iron, total mercury, and total silver; pH values were also measured at times below the BC lower guideline limit. The frequency and magnitude of stream WQG-AL exceedances in baseline studies are presented in Table 3.1-1.

Geographical influences were observed in the distribution of total and dissolved metal WQG-AL exceedances (Table 3.1-1) and summarized as follows:

- Creek 661 watershed – Baseline monitoring at a site in upper Creek 661 adjacent to the footprint of the Open Pit thus had the greatest number of parameters with guideline exceedances for total and dissolved metals. Guideline exceedances for total and dissolved aluminum, total cadmium, and total zinc observed persisted to the downstream monitoring sites in the Creek 661 watershed. Natural elevation of metal concentrations at this site can be attributed to the site's proximity to the Blackwater deposit (see Chapter 2, Baseline Information). The reduced frequencies and factors of exceedance (or absence of exceedance) for total and dissolved cadmium, total silver, and total zinc with downstream distance indicates that these parameters are likely associated with the mineral deposit and are attenuated along the Creek 661 flowpath towards Chedakuz Creek. However, exceedances of total chromium and total copper guidelines observed at all Creek 661 downstream sites (but not in upper Creek 661) suggest these metals are not associated with the mineral deposit.
- Davidson Creek watershed – Exceedances of the WQG-AL were most frequently observed at the upstream sites near the Blackwater deposit. Metal exceedances associated with deposit mineralization in Davidson Creek included total and dissolved cadmium, dissolved iron, and total and dissolved zinc. Consistent with other watersheds, total and dissolved aluminum concentrations were higher than WQG-AL throughout Davidson Creek and followed a similar temporal pattern to TSS, unlike other metals which were dominated by the dissolved fraction.
- Turtle Creek watershed – Overall, concentrations of total and dissolved metals in Turtle Creek were low, with the exception of aluminum concentrations, which were elevated across the entire Project

area. Exceedances of the WQG-AL, with the exception of total and dissolved aluminum, were infrequent at Turtle Creek monitoring locations.

- Chedakuz Creek – WQG-AL exceedances were infrequent in Chedakuz Creek with the exception of total aluminum, consistent with other watersheds. Infrequent WQG-AL exceedances for total zinc were also observed, and can be attributed to elevated zinc concentrations in lower Davidson and Turtle creeks.
- Creek 705 watershed – The Creek 705 watershed drains towards the west away from the Project and water quality in this creek is not expected to be influenced by Project effluent discharges or seepage and is, thus, considered to be a reference location for water quality. Due to mineralization near the Blackwater deposit, guideline exceedances were observed in Creek 705 and tributaries for nine total and dissolved metals: total and dissolved aluminum, total cadmium, total chromium, total copper, dissolved iron, total mercury, and total and dissolved zinc.

Results of the lake baseline sampling indicated that the Project area lakes were near-neutral to slightly alkaline in pH. Measured physical parameters (pH, alkalinity, hardness, and TDS) were slightly higher in the larger Kuyakuz and Tatelkuz lakes, compared to the smaller headwater lakes (Lake 1682, Lake 1538, and Lake 1428) at higher elevations. Kuyakuz and Tatelkuz lakes were both classified as moderately hard lakes. Snake Lake and the three headwater lakes were found to have soft (low hardness) water. Total dissolved solids were typically higher during winter months (representing under-ice measurements) than when measured in summer and early fall. Total suspended solids and turbidity were typically low in Project lakes and exhibited minor seasonal variability. Concentrations of nutrients and anions were generally low, except for occasional ammonia and phosphorus concentrations in samples from the lower layer of lakes, which may have been influenced by capture of lake bottom sediments. Nutrient concentrations and anions did not exceed any applicable water quality guidelines.

Exceedances of WQG-AL in the lakes sampled were geographically controlled, varying by catchment and by distance from the Blackwater deposit. Guideline exceedances were more frequently noted in the lakes located in the headwaters of the Creek 705 watershed to the east of the Project (Lake 1682, Lake 1538, and Lake 1428) than in lakes further away (Tatelkuz Lake, Kuyakuz Lake). The frequency and magnitude of lake WQG-AL exceedances are presented in Table 3.1-2.

The Conceptual Site Model Report (Appendix 5-I and Section 5.10 in Chapter 5 [Modelling, Mitigation, and Discharges]) described briefly in Section 1.5 also considered baseline water chemistry compared to water quality guidelines or standards for the protection of wildlife and livestock (WQG-WL; BC ENV 2019a, 2021; CCME 2021c; BC Reg. 375/96). Although there were three samples out of 702 samples in which mercury concentrations were higher than WQG-WL, no POCs were identified for wildlife ROCs in surface water.

3.1.2.2 Surface Water Quality Model

Predicted surface water quality was generated in a water balance/water quality model for key locations in the downstream receiving environment at assessment nodes for Project Case (95th percentile concentration of 40 iterations of base case predictions; Appendix 5-D, Surface Water Quality Model Technical Report). The surface water quality model incorporates multiple mitigation measures, including best available technology, to reduce the Project's effects on the aquatic receiving environment by minimizing overall effects on surface water quality and the maintenance of instream flow needs in Davidson Creek.

For the most part, the assessment nodes in the surface water quality model were the same as those used as baseline surface water quality monitoring stations including WQ28, WQ27, WQ26, and WQ7 in Davidson Creek, WQ5 in Creek 661, and WQ8, WQ9, and WQ13 in Chedakuz Creek. Additional assessment nodes were added to the base of Creek 661 ("WQCk661" node) just upstream of the confluence with Chedakuz Creek, and at two far-field locations in Chedakuz Creek ("ChedakuzMidway" and "ChedakuzOutlet") to ensure adequate spatial coverage of model predictions.

Table 3.1-1: Summary of Stream Water Quality Frequency and Magnitude of Guideline Exceedances, Blackwater Gold Project, 2011 to 2020

Watershed	Site	Parameter	pH	Nitrite	Total Aluminum	Dissolved Aluminum		Total Arsenic	Total Cadmium		Dissolved Cadmium		Total Chromium	Total Copper
		Guideline	BC Lower Limit	BC Long-term Chronic	CCME Long-term	BC Long-term Chronic	BC Short-term Acute	BC	CCME Long-term	CCME Short-term	BC Long-term Chronic	BC Short-term Acute	BC Interim (Cr[VI])	CCME Long-term
Creek 661 Watershed	**All Sites**	**Factor**	**-**	**1.10**	**2.34**	**2.61**	**1.73**	**1.38**	**2.54**	**1.15**	**2.45**	**1.71**	**1.47**	**2.38**
		Frequency (%)	**0**	**0.645**	**56.1**	**65.1**	**37.5**	**0.645**	**14.8**	**0.645**	**4.52**	**2.58**	**5.16**	**1.29**
	WQ4	Factor	-	-	2.66	2.73	1.67	1.38	2.67	1.15	2.45	1.71	-	-
		Frequency (%)	0	0	72.1	73.8	50.0	2.33	48.8	2.33	16.3	9.30	0	0
	WQ3	Factor	-	1.10	1.96	1.99	1.37	-	1.06	-	-	-	1.47	3.65
		Frequency (%)	0	1.75	47.4	48.2	19.6	0	1.75	0	0	0	14.0	1.75
	WQ5	Factor	-	-	2.34	2.93	1.95	-	1.33	-	-	-	-	1.10
		Frequency (%)	0	0	52.7	75.9	46.3	0	1.82	0	0	0	0	1.82
Davidson Creek Watershed	**All Sites**	**Factor**	**1.02**	**-**	**5.57**	**3.03**	**1.83**	**-**	**1.26**	**-**	**1.15**	**1.00**	**1.51**	**7.38**
		Frequency (%)	**2.15**	**0**	**45.6**	**49.0**	**34.9**	**0**	**1.29**	**0**	**1.29**	**0.215**	**1.08**	**1.29**
	WQ1	Factor	1.02	-	22.5	4.56	2.50	-	1.37	-	1.15	1.00	-	2.73
		Frequency (%)	31.3	0	96.9	100	90.3	0	12.5	0	18.8	3.13	0	6.25
	WQ6	Factor	-	-	2.11	2.58	1.52	-	1.05	-	-	-	-	-
		Frequency (%)	0	0	57.6	59.4	40.6	0	3.03	0	0	0	0	0
	WQ31	Factor	-	-	2.07	2.69	1.93	-	-	-	-	-	-	-
		Frequency (%)	0	0	63.6	90.9	45.5	0	0	0	0	0	0	0
	WQ10	Factor	-	-	2.40	3.12	1.82	-	-	-	-	-	-	-
		Frequency (%)	0	0	43.5	46.2	35.2	0	0	0	0	0	0	0
	WQ28	Factor	-	-	2.57	3.02	1.74	-	-	-	-	-	-	-
		Frequency (%)	0	0	40.0	47.3	36.4	0	0	0	0	0	0	0
	WQ27	Factor	-	-	2.29	2.63	1.66	-	-	-	-	-	-	-
		Frequency (%)	0	0	38.2	47.1	29.4	0	0	0	0	0	0	0
	WQ26	Factor	-	-	2.45	2.66	1.65	-	-	-	-	-	-	8.71
		Frequency (%)	0	0	36.5	39.2	24.3	0	0	0	0	0	0	2.70
	WQ7	Factor	-	-	3.74	2.61	1.55	-	1.04	-	-	-	1.51	10.7
		Frequency (%)	0	0	40.0	37.4	25.3	0	1.00	0	0	0	5.00	2.00
Turtle Creek Watershed	**All Sites**	**Factor**	**-**	**-**	**3.73**	**5.42**	**3.05**	**-**	**1.73**	**-**	**1.49**	**-**	**1.27**	**3.38**
		Frequency (%)	**0**	**0**	**51.3**	**53.9**	**46.1**	**0**	**1.28**	**0**	**1.30**	**0**	**1.28**	**2.56**
	WQ19	Factor	-	-	-	-	-	-	-	-	-	-	-	-
		Frequency (%)	0	0	0	0	0	0	0	0	0	0	0	0
	WQ11	Factor	-	-	3.85	5.52	3.05	-	1.73	-	1.49	-	1.27	3.38
		Frequency (%)	0	0	82.2	90.9	79.5	0	2.22	0	2.22	0	2.22	4.44
	WQ14	Factor	-	-	2.25	1.20	-	-	-	-	-	-	-	-
		Frequency (%)	0	0	10.0	3.45	0	0	0	0	0	0	0	0

Watershed	Site	Dissolved Copper		Total Iron	Dissolved Iron	Total Mercury	Total Silver		Total Zinc		Dissolved Zinc	
		BC Long-term Chronic	BC Short-term Acute	BC Short-term Acute	BC Short-term Acute	BC Long-term Chronic	BC Long-term Chronic	BC Short-term Acute	BC Long-term Chronic	BC Short-term Acute	CCME Long-term	CCME Short-term
Creek 661 Watershed	**All Sites**	**1.57**	**-**	**-**	**1.71**	**-**	**1.93**	**1.37**	**5.31**	**1.46**	**2.44**	**1.48**
		0.645	**0**	**0**	**1.29**	**0**	**5.16**	**1.94**	**31.0**	**20.6**	**27.7**	**12.9**
	WQ4	1.57	-	-	-	-	1.93	1.37	5.71	1.46	2.44	1.48
		2.33	0	0	0	0	18.6	6.98	100	74.4	100	46.5
	WQ3	-	-	-	-	-	-	-	1.41	-	-	-
		0	0	0	0	0	0	0	5.26	0	0	0
	WQ5	-	-	-	1.71	-	-	-	2.60	-	-	-
		0	0	0	3.64	0	0	0	3.64	0	0	0
Davidson Creek Watershed	**All Sites**	**2.78**	**2.20**	**1.34**	**1.68**	**51.1**	**1.60**	**-**	**2.95**	**2.22**	**1.98**	**1.25**
		2.15	**0.215**	**1.29**	**0.430**	**0.430**	**0.215**	**0**	**3.66**	**0.645**	**1.08**	**0.215**
	WQ1	1.65	-	-	1.24	-	-	-	1.29	-	-	-
		28.1	0	0	3.13	0	0	0	9.38	0	0	0
	WQ6	-	-	-	-	-	-	-	2.15	-	1.32	-
		0	0	0	0	0	0	0	6.06	0	3.03	0
	WQ31	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
	WQ10	-	-	-	-	-	1.60	-	1.30	-	1.10	-
		0	0	0	0	0	1.09	0	2.17	0	1.09	0
	WQ28	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
	WQ27	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
	WQ26	-	-	-	-	100	-	-	1.19	-	-	-
		0	0	0	0	1.35	0	0	1.35	0	0	0
	WQ7	13.0	2.20	1.34	2.13	2.10	-	-	4.24	2.22	2.49	1.25
		1.00	1.00	6.00	1.00	1.00	0	0	9.00	3.00	3.00	1.00
Turtle Creek Watershed	**All Sites**	**3.05**	**-**	**1.33**	**3.26**	**401**	**-**	**-**	**1.24**	**-**	**-**	**-**
		2.56	**0**	**2.56**	**1.28**	**2.56**	**0**	**0**	**2.56**	**0**	**0**	**0**
	WQ19	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
	WQ11	3.05	-	-	-	401	-	-	-	-	-	-
		4.44	0	0	0	4.44	0	0	0	0	0	0
	WQ14	-	-	1.33	3.26	-	-	-	1.24	-	-	-
		0	0	6.67	3.33	0	0	0	6.67	0	0	0

Watershed	Site	Parameter	pH	Nitrite	Total Aluminum	Dissolved Aluminum		Total Arsenic	Total Cadmium		Dissolved Cadmium		Total Chromium	Total Copper
		Guideline	BC Lower Limit	BC Long-term Chronic	CCME Long-term	BC Long-term Chronic	BC Short-term Acute	BC	CCME Long-term	CCME Short-term	BC Long-term Chronic	BC Short-term Acute	BC Interim (Cr[VI])	CCME Long-term
Chedakuz Creek Watershed	**All Sites**	**Factor**	**-**	**-**	**1.48**	**1.65**	**1.71**	**-**	**2.12**	**-**	**1.51**	**-**	**2.15**	**1.83**
		Frequency (%)	**0**	**0**	**14.9**	**2.29**	**0.327**	**0**	**0.324**	**0**	**0.324**	**0**	**0.324**	**0.971**
	WQ8	Factor	-	-	1.31	-	-	-	-	-	-	-	-	1.83
		Frequency (%)	0	0	3.53	0	0	0	0	0	0	0	0	3.53
	WQ9	Factor	-	-	1.55	1.24	-	-	-	-	-	-	2.15	-
		Frequency (%)	0	0	19.4	4.12	0	0	0	0	0	0	1.02	0
	WQ13	Factor	-	-	1.35	3.42	1.71	-	2.12	-	1.51	-	-	-
		Frequency (%)	0	0	22.6	1.20	1.20	0	1.19	0	1.19	0	0	0
	WQ29	Factor	-	-	1.89	1.37	-	-	-	-	-	-	-	-
		Frequency (%)	0	0	9.52	4.76	0	0	0	0	0	0	0	0
	WQ30	Factor	-	-	1.79	1.81	-	-	-	-	-	-	-	-
		Frequency (%)	0	0	14.3	4.76	0	0	0	0	0	0	0	0
Creek 705 Watershed	**All Sites**	**Factor**	**-**	**-**	**1.97**	**2.22**	**1.40**	**-**	**1.99**	**-**	**-**	**-**	**13.5**	**1.25**
		Frequency (%)	**0**	**0**	**39.6**	**48.0**	**27.0**	**0**	**2.97**	**0**	**0**	**0**	**1.98**	**0.990**
	WQ15	Factor	-	-	1.16	1.59	-	-	-	-	-	-	-	-
		Frequency (%)	0	0	5.88	29.4	0	0	0	0	0	0	0	0
	WQ16	Factor	-	-	2.32	1.32	-	-	2.44	-	-	-	-	-
		Frequency (%)	0	0	17.6	11.8	0	0	11.8	0	0	0	0	0
	BI-12	Factor	-	-	1.87	2.30	1.37	-	1.10	-	-	-	24.7	1.25
		Frequency (%)	0	0	55.3	56.8	35.1	0	2.63	0	0	0	2.63	2.63
	BI-09	Factor	-	-	2.11	2.39	1.44	-	-	-	-	-	2.20	-
		Frequency (%)	0	0	51.7	69.0	48.3	0	0	0	0	0	3.45	0
Fawnie Creek (reference)	**All Sites (BI-13)**	**Factor**	**-**	**-**	**1.21**	**1.46**	**1.08**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
		Frequency (%)	**0**	**0**	**15.4**	**61.5**	**7.69**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Blackwater River (reference)	**All Sites**	**Factor**	**-**	**-**	**6.03**	**3.23**	**1.62**	**-**	**5.35**	**-**	**2.86**	**1.13**	**6.80**	**2.70**
		Frequency (%)	**0**	**0**	**20.0**	**10.0**	**10.0**	**0**	**10.0**	**0**	**10.0**	**10.0**	**10.0**	**10.0**
	WQ17	Factor	-	-	2.06	3.23	1.62	-	-	-	-	-	-	-
		Frequency (%)	0	0	20.0	20.0	20.0	0	0	0	0	0	0	0
	WQ18	Factor	-	-	10.0	-	-	-	5.35	-	2.86	1.13	6.80	2.70
		Frequency (%)	0	0	20.0	0	0	0	20.0	0	20.0	20.0	20.0	20.0

Watershed	Site	Dissolved Copper		Total Iron	Dissolved Iron	Total Mercury	Total Silver		Total Zinc		Dissolved Zinc	
		BC Long-term Chronic	BC Short-term Acute	BC Short-term Acute	BC Short-term Acute	BC Long-term Chronic	BC Long-term Chronic	BC Short-term Acute	BC Long-term Chronic	BC Short-term Acute	CCME Long-term	CCME Short-term
Chedakuz Creek Watershed	**All Sites**	**8.43**	**1.40**	**-**	**1.04**	**550**	**5.10**	**2.55**	**3.01**	**1.76**	**1.48**	**-**
		0.324	**0.324**	**0**	**0.324**	**0.324**	**0.324**	**0.324**	**1.29**	**0.324**	**0.324**	**0**
	WQ8	-	-	-	1.04	-	5.10	2.55	1.55	-	-	-
		0	0	0	1.18	0	1.18	1.18	1.18	0	0	0
	WQ9	8.43	1.40	-	-	-	-	-	1.03	-	1.48	-
		1.02	1.02	0	0	0	0	0	1.02	0	1.02	0
	WQ13	-	-	-	-	550	-	-	4.73	1.76	-	-
		0	0	0	0	1.19	0	0	2.38	1.19	0	0
	WQ29	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
	WQ30	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
Creek 705 Watershed	**All Sites**	**-**	**-**	**-**	**1.18**	**150**	**-**	**-**	**1.40**	**-**	**1.02**	**-**
		0	**0**	**0**	**1.98**	**0.990**	**0**	**0**	**1.98**	**0**	**0.990**	**0**
	WQ15	-	-	-	-	150	-	-	-	-	-	-
		0	0	0	0	5.88	0	0	0	0	0	0
	WQ16	-	-	-	-	-	-	-	1.20	-	-	-
		0	0	0	0	0	0	0	5.88	0	0	0
	BI-12	-	-	-	1.18	-	-	-	1.60	-	1.02	-
		0	0	0	5.26	0	0	0	2.63	0	2.63	0
	BI-09	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
Fawnie Creek (reference)	**All Sites (BI-13)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
		0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Blackwater River (reference)	**All Sites**	**1.24**	**-**	**3.70**	**-**	**-**	**-**	**-**	**19.5**	**4.42**	**4.95**	**1.22**
		10.0	**0**	**10.0**	**0**	**0**	**0**	**0**	**10.0**	**10.0**	**10.0**	**10.0**
	WQ17	-	-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0	0
	WQ18	1.24	-	3.70	-	-	-	-	19.5	4.42	4.95	1.22
		20.0	0	20.0	0	0	0	0	20.0	20.0	20.0	20.0

Notes:
Refer to Attachment D for 2020 guideline values.
Values below the detection limit were replaced with half the detection limit for calculations.
Only parameters above guidelines are included in table.
Samples with detection limits greater than guideline values were excluded from factor and frequency calculations.
Factor represents the average magnitude of samples above guideline concentrations (for pH BC Lower Limit, it represents the average factor below the lower limit).
Frequency (%) represents percentage of samples collected at each site that were higher than available guidelines.

Table 3.1-2: Summary of Lake Water Quality Frequency and Magnitude of Guideline Exceedances, Blackwater Gold Project, 2011 to 2020

Watershed (Site)	Parameter	Total Aluminum	Total Arsenic	Total Cadmium	Total Copper	Dissolved Copper	Total Iron	Dissolved Iron	Total Lead	Total Manganese		Dissolved Manganese	Total Mercury	Total Zinc	Dissolved Zinc
	Guideline	CCME Long-term	BC	CCME Long-term	CCME Long-term	BC Long-term Chronic	BC Short-term Acute	BC Short-term Acute	BC Long-term	BC Long-term	BC Short-term	CCME Long-term	BC Long-term Chronic	BC Long-term Chronic	CCME Long-term
Kuyakuz Lake (WQ20)	Factor	2.35	-	-	1.40	-	-	-	2.08	-	-	1.28	-	1.49	-
	Frequency (%)	11.1	0	0	11.1	0	0	0	11.1	0	0	11.1	0	11.1	0
Tatelkuz Lake (WQ21)	Factor	-	-	1.01	-	-	-	-	-	-	-	-	-	2.15	-
	Frequency (%)	0	0	7.14	0	0	0	0	0	0	0	0	0	14.3	0
Snake Lake (WQ22)	Factor	-	-	-	-	-	-	-	-	-	-	-	-	1.35	-
	Frequency (%)	0	0	0	0	0	0	0	0	0	0	0	0	16.7	0
Lake 1682 (WQ23)	Factor	-	2.54	-	1.65	2.20	4.38	12.3	-	-	-	1.47	-	1.82	1.44
	Frequency (%)	0	4.00	0	4.00	4.00	4.00	4.00	0	0	0	4.00	0	8.00	8.00
Lake 1538 (WQ24)	Factor	-	1.24	2.15	-	-	3.55	9.23	-	1.32	1.12	2.89	1.20	-	-
	Frequency (%)	0	9.09	9.09	0	0	9.09	9.09	0	9.09	9.09	9.09	9.09	0	0
Lake 1428 (WQ25)	Factor	-	-	1.64	-	-	7.97	20.3	-	2.07	1.65	4.05	-	-	-
	Frequency (%)	0	0	22.2	0	0	11.1	11.1	0	11.1	11.1	11.1	0	0	0

Notes:

Refer to Attachment D for 2020 guideline values.

Values below the detection limit were replaced with half the detection limit for calculations.

Only parameters above guidelines are included in table.

Samples with detection limits greater than guideline values were excluded from factor and frequency calculations.

Factor represents the average magnitude of samples above guideline concentrations.

Frequency (%) represents percentage of samples collected at each site that were higher than available guidelines.

Similar to the baseline surface water quality data, the surface water quality model predictions for each of the assessment nodes were screened against applicable BC or federal WQG-AL (BC ENV 2019a, 2021; CCME 2021a) and WQG-WL (BC ENV 2019a, 2021; CCME 2021c; BC Reg. 375/96). Parameters of potential concern were identified when the predicted concentration was greater than 80% of the WQG-AL or WQG-WL during the Construction and/or Operations phase. Parameters of concern were a subset of the POCs and were identified when predicted concentrations were higher than WQG-AL or WQG-WL and higher than background (baseline) concentrations.

Parameters of potential concern for aquatic life included: nitrite; fluoride; total and dissolved aluminum; total cadmium; total chromium; total iron; and total zinc. Of these parameters, no POCs were identified. However as noted in Section 1.5, nutrients (nitrate, nitrite, ammonia, and total phosphorus) and TDS were also identified as special case POCs, although WQG-AL were either not exceeded or not available for these parameters. No POPCs or POCs were identified for wildlife based on water quality predictions at the assessment nodes.

3.2 Sediment

Baseline sediment quality monitoring was conducted in 2011, 2012, 2013 and 2017 in the following watercourses (Figure 3.2-1; Appendix 2-M, 2013 Baseline Report Surface Water and Sediment Quality, and Appendix 2-N, 2017 Cumulative Aquatic Resources Baseline Report):

- Davidson Creek, Creek 661, Turtle Creek, and Creek 705;
- tributaries flowing into the south side of Tatelkuz Lake;
- Chedakuz Creek, from confluence with Creek 661 to Tatelkuz Lake;
- Chedakuz Creek, from Tatelkuz Lake to confluence with Turtle Creek; and
- Fawnie Creek Tributary.

Sediment quality site names were updated after the completion of baseline sampling to reflect the creek/lake name and to coincide with the proposed water quality sampling site locations (Attachment D).

Stream sediments in the Project area are generally characterized by relatively low metal concentrations and are dominated by sand and gravel-sized sediments. Overall, the 2017 concentrations were generally lower with more uniform distribution within watersheds than in previous years. Exceedance of sediment quality guidelines (SQGs; BC ENV 2021 and CCME 2021b) were found at reference sites and sites in watercourses downstream of the Project mine site (Tables 3.2-1 and 3.2-2).

Table 3.2-1: Parameters with Exceedances of Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life, Blackwater Gold Project, 2012 to 2013

Site	CCME ISQG	CCME PEL	ENV Lowest Effects	ENV Severe Effects
Reference Sites and Creek 705				
WQ17	Arsenic, Iron	-	Arsenic, Iron	-
WQ18	Chromium, Iron	-	Chromium, Iron, Nickel	-
WQ15	Mercury	-	Mercury	-
Davidson Creek				
WQ6		Arsenic		Arsenic
WQ1	Arsenic, Cadmium, Zinc	-	Arsenic, Cadmium, Zinc	-
WQ10	Arsenic	-	Arsenic	-

Site	CCME ISQG	CCME PEL	ENV Lowest Effects	ENV Severe Effects
WQ7		-	Nickel	-
Turtle Creek				
WQ19	Chromium	-	Chromium, Nickel	-
WQ11		-		-
WQ14	Zinc	Arsenic, Iron	Zinc	Arsenic, Iron
Creek 661				
WQ4	Iron, Mercury	Arsenic, Cadmium, Zinc	Iron, Mercury, Nickel	Arsenic, Cadmium, Silver, Zinc
WQ5	Arsenic	-	Arsenic	-
Chedakuz Creek				
WQ13	Arsenic, Iron	-	Arsenic, Iron	-

Notes:

Dashes indicate there were no parameter that exceeded the guideline.

ENV = British Columbia Ministry of Environment and Climate Change Strategy; CCME = Canadian Council of Ministers of the Environment; ISQG = Interim Sediment Quality Guidelines; PEL = Probable Effect Level

Table 3.2-2: Exceedances of Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life, Blackwater Gold Project, 2017

Parameter			Arsenic	Iron	Manganese
Jurisdiction			BC = CCME[1,2]	BC[1]	BC[1]
Guideline			Lower	Lower	Lower
			5.9	21,200	460
Site		Replicates	Factor	Factor	Factor
Reference Sites and Creek 705	BI-13	5	1.8	1.3	-
	WQ12	5	-	-	1.2
	BI-09	5	-	-	1.4
Davidson Creek	WQ10	5	1.7	-	-
	WQ28	5	1.3	-	-
	WQ27	5	2.0	-	1.0
Creek 661	WQ3	5	1.1	-	-
	WQ5	5	1.4	-	1.2
Chedakuz Creek	WQ8	5	-	-	-
	WQ13	5	1.3	-	-

Notes:

All units in mg/kg; only parameters with concentrations above sediment quality guidelines are shown.

Half the method detection limit was substituted for values below the method detection limit.

Split samples were averaged before calculations.

Factor represents the factor by which average sediment concentrations were greater than guideline concentrations.

[1] British Columbia working sediment quality guidelines for the protection of freshwater aquatic life.

[2] Canadian Council of Ministers of Environment sediment quality guidelines for the protection of aquatic life.

Lake sediments were also sampled in 2013 at five locations in the Project area – Tatelkuz Lake, Snake Lake, Lake 1682, Lake 1428, and Lake 1538 (Appendix 2-M, 2013 Baseline Report Water and Sediment Quality). Sediment chemistry results indicated that all lake sediments tended to be slightly acidic and sediment metal concentrations were low and generally similar concentrations amongst the lakes sampled. Total organic carbon ranged from less than 1% in Tatelkuz Lake to 27% in Snake Lake. Particle size composition tended to be dominated by sand and silts, suggesting that metals in lake bottom sediments were loosely bound and easily leached. The loose binding of metals may have resulted from the relatively low organic content and mostly fine particle size. Exceedance of SQGs for copper, lead, mercury, and zinc were noted in all sampled lakes with the exception of Tatelkuz Lake.

3.3 Aquatic Primary Producers

Periphyton were sampled in 2011, 2012, and 2017 to characterize spatial and temporal background (baseline) conditions of aquatic resources in watercourses downstream of the mine site (Appendix 2-N, 2017 Cumulative Aquatic Resources Baseline Report and Appendix 2-O, Fish and Aquatic Resources 2011 – 2012 Baseline Report).

Aquatic resource baseline sampling locations were selected to align with water quality and sediment quality sampling locations. Thus sites were located on Davidson Creek, Creek 661, Tatelkuz Lake Tributaries, Creek 705, Turtle Creek, and reference sites on Fawnie Creek Tributary and a Blackwater River Tributary (Figure 3.3-1). Plankton (phytoplankton and zooplankton) were sampled in three headwater lakes (Lake 1682, Lake 1428, and Lake 1538) in September 2012 (Appendix 2-O, Fish and Aquatic Resources 2011 – 2012 Baseline Report). Tatelkuz Lake was also sampled in two locations for plankton in mid-August 2013 (Appendix 2-P, Fish and Aquatic Resources 2013 Baseline Report). Aquatic resource site names have been updated since completion of baseline sampling to reflect the creek/lake name and coincide with water quality sample locations (Attachment D).

Periphyton biomass (as chlorophyll *a*) was typically low throughout all sampled streams. Overall, periphyton biomass and density data suggest that streams have low to moderate primary productivity. All sites were dominated by blue-green algae and diatoms. Davidson Creek was the only watershed with red algae during the 2017 sampling program.

Mean phytoplankton biomass (as chlorophyll *a*) in the headwater lakes (lakes 1682, 1538, and 1428) suggest that the headwater lakes are oligotrophic. In contrast, Tatelkuz Lake higher phytoplankton biomass indicated the lake is mesotrophic. Higher productivity in Tatelkuz Lake is likely driven by landscape position (e.g., high water temperature due to lower elevation) and greater nutrient concentrations. Phytoplankton community diversity indices indicated that the three headwater lakes are dominated by a few abundant taxa. Phytoplankton communities in the sampled headwater lakes were dominated by Chrysophyta (including diatoms), though Cryptophyta were dominant at the thermocline in Lake 1682. Chrysophyta, Cryptophyta, and cyanobacteria were co-dominant in the epilimnion of Tatelkuz Lake.

Mean zooplankton density in two of the headwater lakes (lakes 1682 and 1538) was lower relative to Lake 1428 and Tatelkuz Lake. Tatelkuz Lake is two- to four-fold deeper relative to the headwater lakes and given the depth integrated sampling procedure (sampling the entire water column) the surface waters of Tatelkuz are likely to be more productive than the headwater lakes with regard to zooplankton. The interpretation of higher productivity in Tatelkuz surface waters is also supported by mean phytoplankton biomass results. Zooplankton communities in the headwater lakes (lakes 1682, 1538, and 1428) were dominated by rotifers, though copepods were co-dominant in Lake 1682. In Tatelkuz Lake, copepods were dominant, though rotifers accounted for a substantial proportion of the zooplankton community.

3.4 Aquatic Invertebrates

Stream benthic invertebrates were sampled in 2011, 2012, and 2017 to characterize spatial and temporal background (baseline) conditions of aquatic resources in the Project area (Appendix 2-N, 2017 Cumulative Aquatic Resources Baseline Report; Appendix 2-O, Fish and Aquatic Resources 2011-2012 Baseline Report; and Appendix 2-P, Fish and Aquatic Resources 2013 Baseline Report). Sites were located at the same locations as sediment and periphyton sampling on Davidson Creek, Creek 661, Tatelkuz Lake Tributaries, Creek 705, Turtle Creek, and reference sites on Fawnie Creek Tributary and a Blackwater River Tributary (Figure 3.3-1). Lake benthic invertebrate sampling was conducted to assess baseline lake communities (density and taxonomic composition) in three headwater lakes (Lake 1682, Lake 1428, and Lake 1538) in September 2012. Tatelkuz Lake was also sampled in two locations for lake benthic invertebrates in mid-August 2013. Aquatic resource site names have been updated since completion of baseline sampling to reflect the creek/lake name and coincide with water quality sample locations (Attachment D).

Stream benthic invertebrate communities sampled in 2011 and 2012 were assessed using CABIN assessment tools to understand among-site differences and to assess the suitability of CABIN reference models for analysis using the Reference Condition Approach (RCA). The Skeena 2010 model was considered appropriate and based on habitat characteristics, all but two sites (lower Davidson Creek and upper Creek 705) were classified as moderately productive with low intrusive bedrock and relatively low levels of precipitation (Group 2 reference condition). Lower Davidson Creek benthic invertebrate community samples were mildly divergent from the reference condition of its assigned reference group (Group 4: highest productivity streams with highest levels of lakes and wetlands). However, Lower Davidson Creek benthic invertebrate community samples were similar to other Project area streams and their reference group (Group 2). In lower Chedakuz Creek, benthic invertebrate community samples were mildly divergent, divergent, or highly divergent, suggesting that the benthic invertebrate community is stressed, possibly due to existing anthropogenic activity (e.g., cattle grazing) in the area.

The 2017 results were similar to the 2011 and 2012 observations with the greatest abundance at Davidson Creek and richness and diversity generally increased with downstream distance. Benthic invertebrate communities were generally diverse with a high abundance of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa and dominated by mayflies, chironomids, and stoneflies.

Profundal benthic invertebrate densities were very low in Lake 1682 and in Lake 1538, likely related to anoxic habitat conditions near profundal sediments. Density of profundal benthic invertebrates in Lake 1428 is characterized as moderate while Tatelkuz Lake benthic invertebrate densities were significantly greater when compared to the sampled headwater lakes. Chironomids dominated profundal benthic invertebrate communities, except in Lake 1428 where fingernail clams were dominant. Profundal benthic invertebrate diversity was also low among the lakes sampled. Mean littoral benthic invertebrate abundance in Tatelkuz Lake was an order of magnitude greater when compared to the headwater lakes, while the abundance of EPT taxa, which are sensitive to nutrients, were significantly lower. In general, the benthic invertebrate communities (littoral and profundal) of Tatelkuz Lake are distinct from the sampled headwater lakes likely as a result of the nutrient-enriched condition and the unique morphology and habitat heterogeneity of Tatelkuz Lake relative to the smaller headwater lakes.

3.5 Fish and Fish Habitat

Baseline fish and fish habitat characterization in Project streams and lakes is provided Appendices 2-O (Fish and Aquatic Resources 2011- 2012 Baseline Report) and Appendix 2-P (Fish and Aquatic Resources 2013 Baseline Report). Fish community baseline studies were completed between 2011 and 2013. Fish surveys were completed to assess species richness, relative abundance, spatial distribution, and biological characteristics. In addition, the fish community data was used to identify the number of breeding populations, the locations of their critical habitat, and their migration routes.

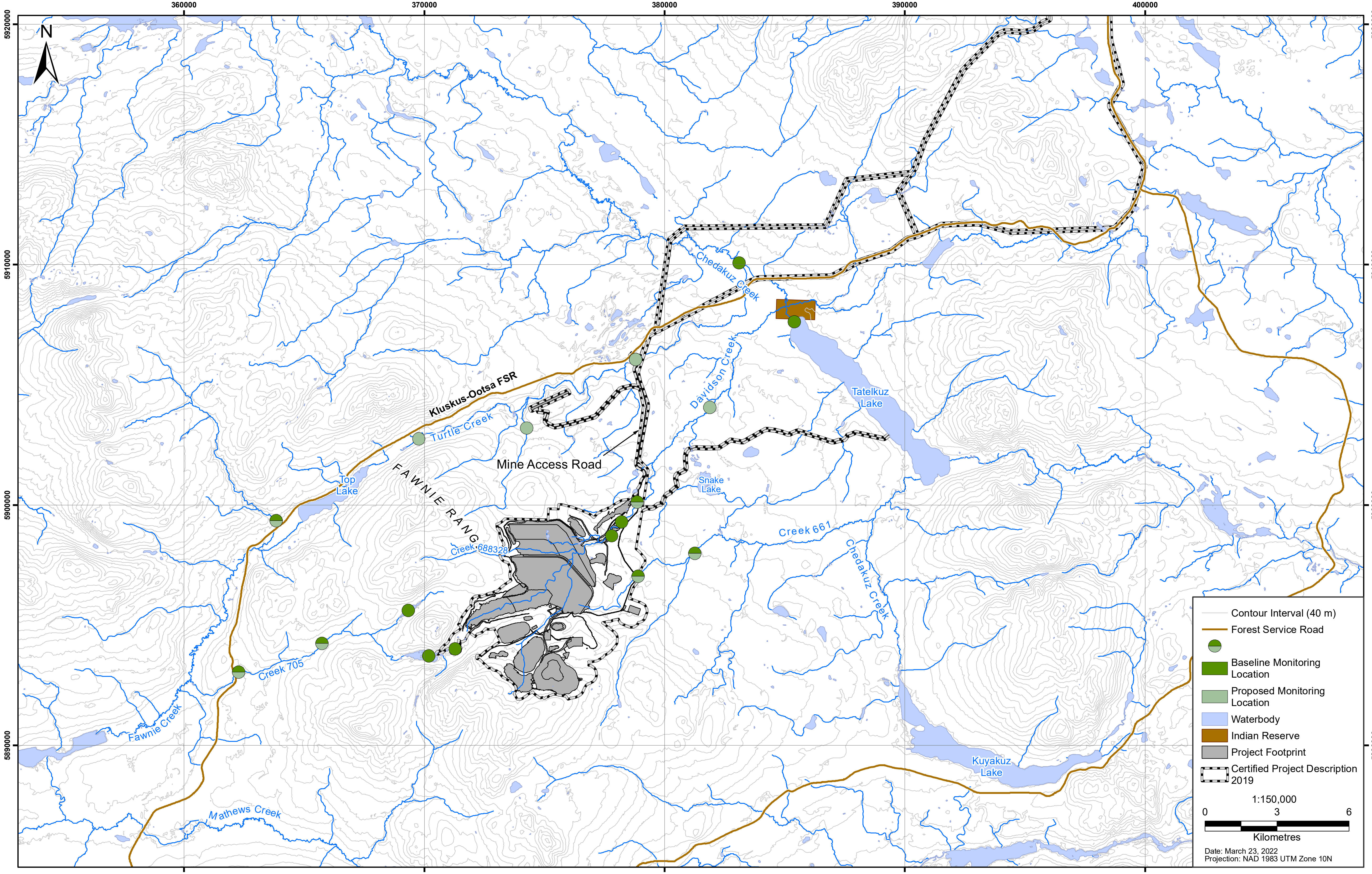

Figure 3.3-1: Baseline and Proposed Sampling Locations for Aquatic Resources

Twelve species of fish were captured in the Project area streams, including kokanee (*Oncorhynchus nerka*), rainbow trout (*Oncorhynchus mykiss*), lake chub (*Couesius plumbeus*), longnose sucker (*Catostomus catostomus*), brassy minnow (*Hybognathus hankinsoni*), mountain whitefish (*Prosopium williamsoni*), burbot (*Lota lota*), longnose dace (*Rhinichthys cataractae*), slimy sculpin (*Cottus cognatus*), northern pikeminnow (*Ptychocheilus oregonensis*), largescale sucker (*Catostomus macrocheilus*), and white wucker (*Catostomus commersonii*). The geographic distribution of fish in the study area are summarized in Table 3.5-1 and Figure 3.5-1.

Table 3.5-1: Fish Species Observed in the Streams and Lakes, 2011, 2012, and 2013

Stream/Lake	RB	LSU	MW	KO	CSU	NSC	BB	CCG	LKC	BMC	WSU	LNC	Total Species
Davidson Creek	✓	-	✓	✓	-	-	-	-	-	-	-	-	**3**
Chedakuz Creek	✓	✓	-	✓	-	-	-	✓	-	-	-	✓	**5**
Turtle Creek	✓	-	-	-	-	-	-	-	-	-	-	-	**1**
Creek 661	✓	-	-	✓	-	-	-	-	-	-	-	-	**2**
Creek 705	✓	✓	✓	-	-	-	✓	-	-	-	-	-	**4**
Tatelkuz Lake	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	**10**
Lake 01682LNRS	✓	-	-	-	-	-	-	-	-	-	-	-	**1**
Lake 01538UEUT	✓	✓	-	-	-	-	-	-	-	-	-	-	**2**
Lake 01428UEUT	✓	✓	-	-	-	-	-	-	-	-	-	-	**2**
Snake Lake	-	-	-	-	-	-	-	-	✓	-	-	-	**1**
Subtotal	**9**	**5**	**3**	**4**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	

Source: Palmer (2016)

Notes:

Dashes indicate not captured during surveys.

RB = rainbow trout; LSU = longnose sucker; MW = mountain whitefish; KO = kokanee; CSU = largescale sucker; NSC = northern pikeminnow; BB = burbot; CCG = slimy sculpin; LKC = lake chub; BMC = brassy minnow; WSU = white sucker; LNC = longnose dace.

Rainbow trout was the most common and were present in every watercourse and lake sampled with the exception of Snake Lake (Table 3.5-1). Longnose sucker were the second most common species, followed by mountain whitefish, and then kokanee. The remaining nine species were each present in only one to three waterbodies (Table 3.5-1).

Watercourses downstream of the Project contain three populations of kokanee: one population inhabits Kuyakuz Lake and spawns in tributaries of the lake and the main channel of Chedakuz Creek downstream from Kuyakuz Lake; and two populations inhabit Tatelkuz Lake, one spawning in August in one set of creeks and the other spawning in September in a different set of creeks.

Fish habitat surveys indicate that Davidson Creek is differentiated into three sections (Figure 3.5-1): Lower Davidson Creek (Reaches 1 to 4) extends upstream from the confluence with Chedakuz Creek approximately 6 km; Middle Davidson Creek (Reaches 5 to 8) is approximately 11 km in length; Upper Davidson Creek (Reaches 9 to 12) is approximately 6 km in length. The lower reaches of the headwater tributaries to Davidson Creek provide good quality spawning (i.e., typically riffle-pool morphology) and rearing habitat for rainbow trout (i.e., cover in the form of large woody debris, overhanging vegetation, and under-cut banks, is abundant). Upstream of this the habitat quality declines with substrates more embedded with silt and fine organics and there are limited pools with sufficient depth and flow to support overwintering fish.

Lower Chedakuz Creek provides approximately 65% of the available kokanee spawning habitat of the streams assessed in the Project area. The habitat is also highly suitable for juvenile rainbow trout rearing with deep pools and instream vegetation providing cover. Chedakuz Creek provides approximately 30% of rainbow trout spawning habitat and 25% of rearing habitat of the streams assessed.

Multiple wetlands have formed in Turtle Creek, particularly in the lower half of the watershed, as a result of beaver activity. Juvenile rearing habitat is ideal in the beaver dam ponds and other unimpounded areas with abundant cover in the form of overhanging vegetation, deep pools, and woody debris.

Creek 661, fed by three headwater tributaries (Creek 505659, Creek 146920, and Creek 543585), has limited available kokanee spawning habitat. Above Reach 3, the habitat appears to only be used by rainbow trout, primarily for rearing. Spawning habitat is generally restricted to Reach 4. Habitat in the lower reaches of Creek 505659 is suitable for all rainbow trout life stages and is predominantly riffle, contains abundant stream cover as well as suitable spawning gravels. Habitat in Creek 146920 and Creek 543585 is only suitable for summer rearing.

The lower to middle reaches of Creek 705 (downstream of Lake 01538UEUT) contain good quality habitat for rainbow trout spawning, rearing and overwintering.

Streams in the Tatelkuz Lake tributary watershed are typically narrow, shallow, and low gradient and support only limited rearing habitat. Spawning habitat is absent in most of these streams and there is little to no overwintering habitat.

3.6 Water-dependent Wildlife

Field surveys were conducted for pond-breeding amphibians and waterbirds in 2011, 2012, 2013, and 2017 using the modified Resource Inventory Standards Committee (RISC) protocols. Baseline monitoring results of water-dependent wildlife in Project lakes and wetlands is provided in Appendix 2-R (Wildlife and Wildlife Habitat Baseline Report) and Appendix 2-S (Consolidated Wildlife Effects Assessment).

Western toad (*Anaxyrus boreas)* surveys were completed in 2011, 2012, and 2013 using time constrained road surveys. Four amphibian species were observed during baseline surveys; all species were confirmed breeding within the mine site in roadside ditch habitat. The indicator species for amphibians, western toad, was one of four species observed. Western toad is federally listed as special concern by COSEWIC and *SARA* (Government of Canada 2020). Habitat suitability mapping identified ditches, ephemeral ponds, lake margins, and wetlands as potential breeding habitat in the Project area.

Aerial waterbird surveys were completed in 2012, 2013, and 2017. A total of nine waterbird species were detected within the mine site and at 10 locations in the Project area. Waterbirds were generally observed at small waterbodies (< 16 ha) and located in lower elevation areas. Yellow rail, an indicator species and species at risk, was not detected during targeted surveys; no other waterbird species at risk were detected. Wilson's snipe (*Gallinago delicate*) was the most commonly detected waterbird within the mine site and the Project area. Many of these observations were of males performing courtship displays within harvested areas. No broods or nests were confirmed for waterbird species within the mine site and local study area.

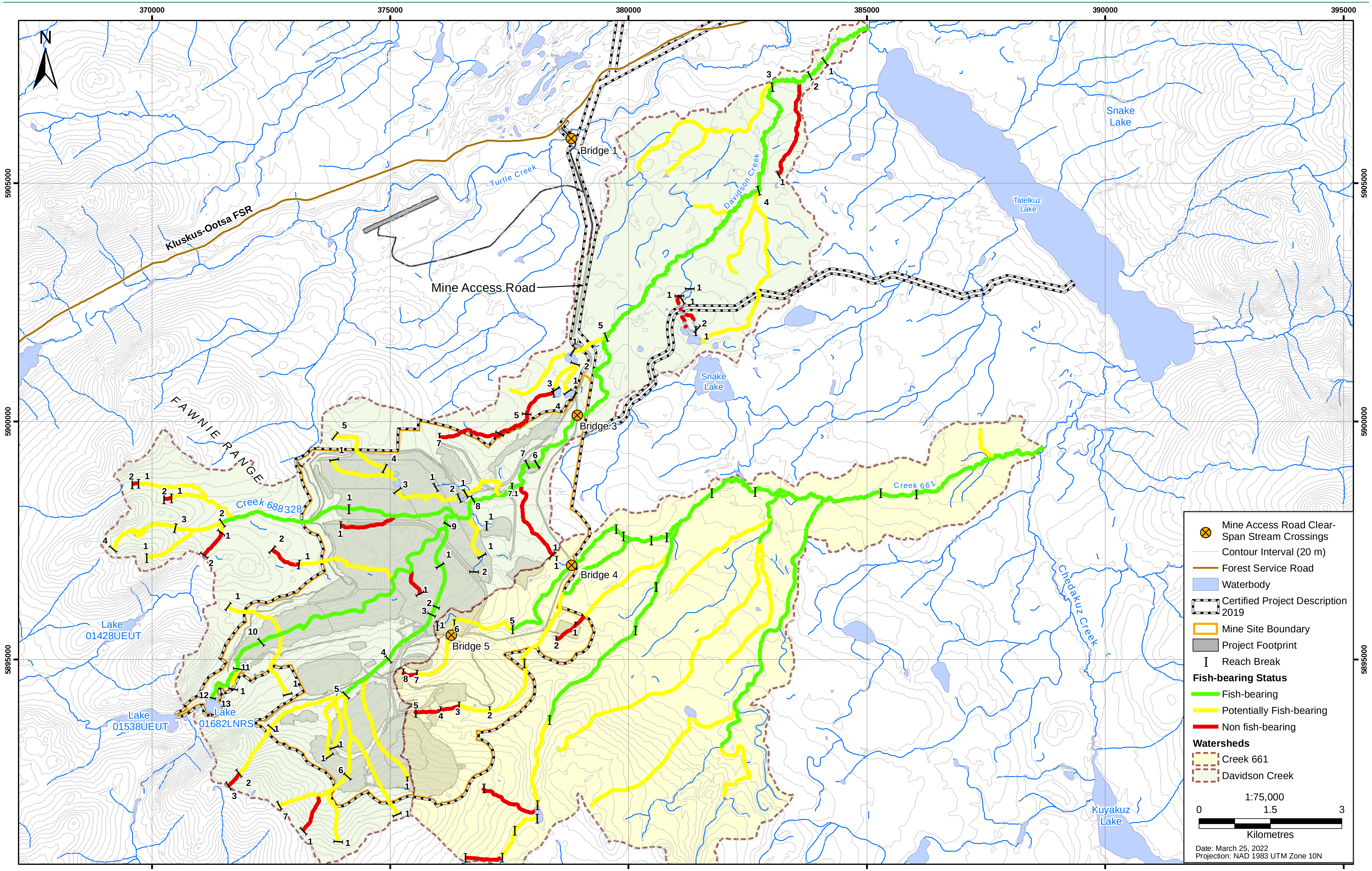

Figure 3.5-1: Fish-Bearing Stream Status

4. DESIGN OF THE AQUATIC EFFECTS MONITORING PROGRAM

The AEMP has been designed to assess the potential long-term effects (i.e., changes from year to year) in each of the physical, chemical, and biological components identified in Section 1.4. For each of the AEMP components, sampling and data analysis has been designed to address the following questions:

- Are AEMP component assessment endpoints at impact sites changing from background (baseline) or reference ranges (e.g., concentrations higher than the background or reference ranges) as a result of the Project?
- Are AEMP component assessment endpoints changing in ways that were not predicted by models or is mitigation less successful than anticipated (e.g., concentrations of parameters in water higher than predicted by surface water quality model)?
- Are AEMP component assessment endpoints at impact sites changing to levels that may be associated with effects (e.g., exceeding a WQG or other benchmark) as a result of the Project?

These questions also directly feed into the adaptive management framework described in Section 6.2 to define triggers for various action levels.

4.1 Study Area

The Project is located on the Nechako Plateau in the Nechako River watershed within the Fraser River drainage. Specifically, the Blackwater deposit is located on the north slope of Mount Davidson, in the headwaters of the Davidson Creek watershed. Davidson creek flows northwest from the Project site towards Chedakuz Creek, with the confluence of the two creeks being approximately 800 m downstream of Tatelkuz Lake (Figure 4.1-1).

Turtle Creek and Creek 661 are parallel drainages to Davidson Creek that also flow northeast to Chedakuz Creek, which then flows northwest to the Nechako Reservoir.

Creek 705 is located on the southern side of a topographic divide from the aforementioned catchments and flows southwest to Fawnie Creek.

Water discharged from the mine site via the FWR outlet reports directly to upper Davidson Creek, which enters Chedakuz Creek downstream of Tatelkuz Lake. Unrecovered seepage from mine site infrastructure (primarily TSF C and TSF D) is also expected to report to Davidson Creek downstream of the FWR. There will be two SCPs that will discharge to Davidson Creek (from the TSF Stage 1 SCP [Construction phase only] and Aggregate Borrow Area SCP [Construction to Closure phase]), as well as a SCP at the Plant Site that will discharge to Creek 661 during Construction phase and the Camp Site SCP that will discharge to Creek 661 during Construction, Operations, and Closure phases.

Thus, the AEMP study area includes four stream watersheds and one lake anticipated to be potentially influenced by mine-related activities as they are downstream of mine infrastructure or discharge points:

- Davidson Creek;
- Turtle Creek[1];
- Creek 661;
- Chedakuz Creek; and
- Tatelkuz Lake.

[1] Turtle Creek is the watershed where the Project airstrip would be located; until the airstrip is constructed, AEMP sampling sites in Turtle Creek will be considered reference sites because water quality would not be affected in this portion of the creek.

The study area also includes three stream watersheds and one lake outside of the immediate zone of influence of the Project and are considered reference sites:

- Creek 705[2];
- Fawnie Creek Tributary;
- Matthews Creek; and
- Kuyakuz Lake.

The AEMP study area watersheds in relation to the Project is provided in Figure 4.1-1, with a description of each watershed in the following sections.

4.1.1 Davidson Creek

Davidson Creek watershed is a sub-watershed of the Chedakuz Creek watershed. Davidson Creek is a third order stream draining the Blackwater property, flowing northeast into Chedakuz Creek north of Tatelkuz Lake. Davidson Creek watershed contains the majority of Project facilities, including TSF C, TSF D, the Open Pit, and related mine site water management structures.

Project discharge from the FWR outlet, which includes treated contact water and diverted non-contact water, will discharge into upper Davidson Creek during Construction and Operations phases. Runoff from the extreme upper extents of the Davidson Creek watershed will be permanently diverted to the Creek 705 watershed as part of TSF construction. During mining operations, water from Tatelkuz Lake will be used to provide instream flow needs (IFN) in Davidson Creek. Saik'uz First Nation asserts that the lower reaches of Davidson Creek are within SFN's traditional territory and, therefore, the lower reaches of the stream have been classified as a Class III waterbody for the purposes of the YDWL (Sinclair et. al. 2017).

4.1.2 Turtle Creek

The Turtle Creek watershed is a sub-watershed of the Chedakuz Creek watershed. Turtle Creek is a third order stream north of Davidson Creek. It originates east of Top Lake, the headwaters of Fawnie Creek. Turtle Creek enters Chedakuz Creek approximately 2 km downstream of the Davidson Creek confluence in a wetland area. No mining facilities are located in this watershed; however, the airstrip, and limited portions of the proposed mine access road will be located within the Turtle Creek watershed. Turtle Creek has been classified as a Class III waterbody for the purposes of the YDWL (Sinclair et al. 2017). Until the airstrip is constructed, Turtle Creek sampling locations will be considered reference sites.

4.1.3 Creek 661

The Creek 661 watershed is a sub-watershed of the Chedakuz Creek watershed, draining into Chedakuz Creek upstream of Tatelkuz Lake. Creek 661 is a third order stream with two branches originating east of the Project site. A tributary to Creek 661 is located within the footprint of mining facilities, including a portion of the proposed Open Pit and potentially may receive seepage from the TSF (Figure 4.1-1). Creek 661 has been classified as a Class III water for the purposes of YDWL (Sinclair et al. 2017).

[2] Creek 705 is considered to be a reference site for all aquatic components except hydrology. No Project discharge or seepage is predicted to report to Creek 705 and no changes to water quality are predicted for Creek 705 and, therefore, no change to aquatic resources are expected as a result of water quality changes.

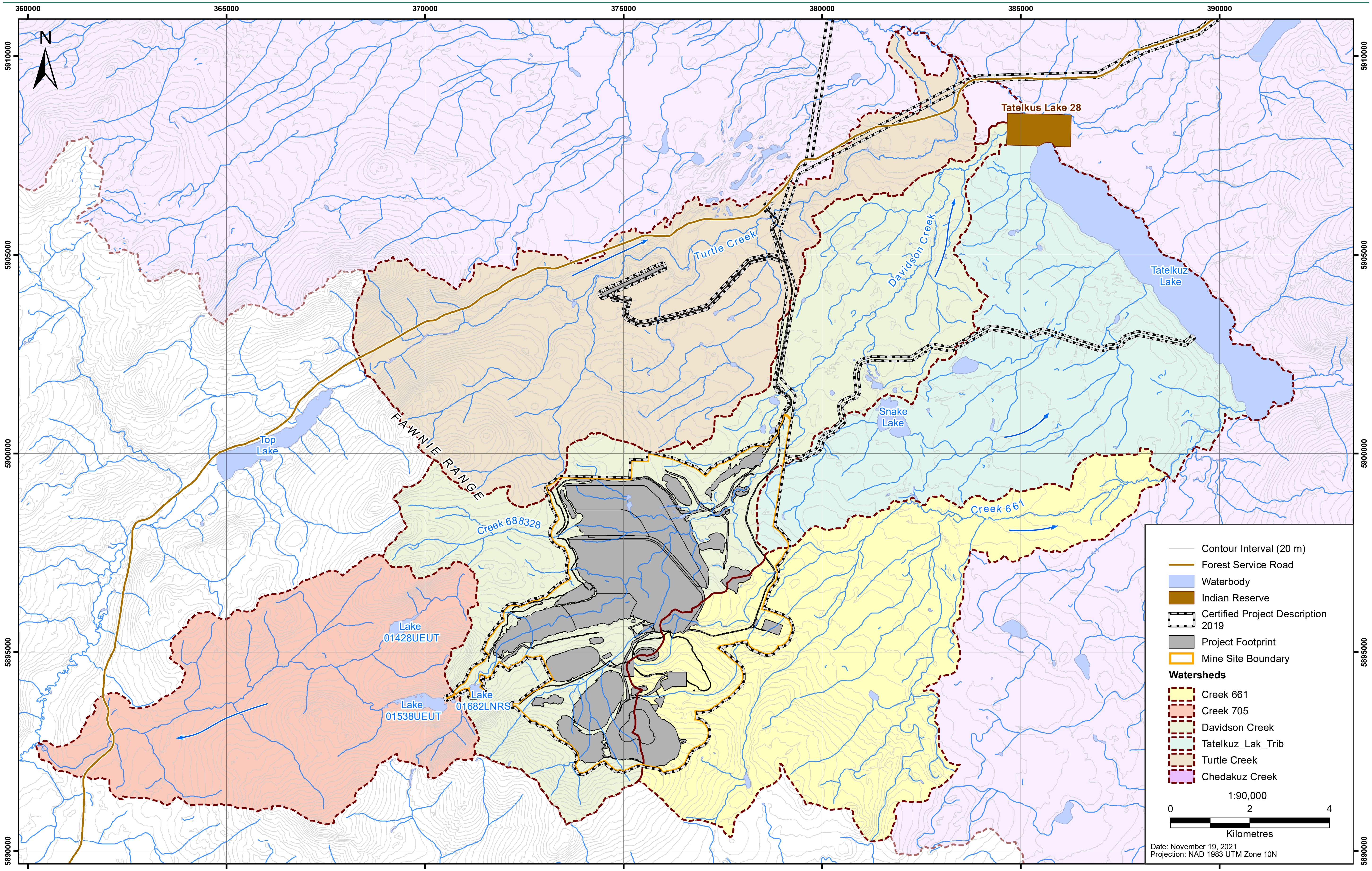

Figure 4.1-1: Study Area for Aquatic Effects Monitoring Program

4.1.4 Chedakuz Creek

Chedakuz Creek is a third to fourth order stream that originates above Kuyakuz Lake and flows approximately northwest to the Nechako Reservoir. Upper Chedakuz Creek is approximately 15 km long and flows into Kuyakuz Lake. Middle Chedakuz Creek is approximately 12 km long and flows between Kuyakuz and Tatelkuz lakes. Downstream of Tatelkuz Lake, Lower Chedakuz Creek flows northwest to the Nechako Reservoir for approximately 53 km. The Creek 661, Davidson Creek, and Turtle Creek watersheds, with associated mining infrastructure, are all contained within the Chedakuz Creek watershed. Chedakuz Creek is classified as a Class II waterbody for the purposes of the YDWL.

4.1.5 Tatelkuz Lake

Tatelkuz Lake is the second largest lake near the headwaters of Chedakuz Creek. It has a surface area of 927 ha, a volume of 188 Mm^3, and a mean depth of 20 m. Tatelkuz Lake has six inlets and one outlet. The lake is categorized by exposed cobble and sandy beaches, and by a forested shoreline and supports a several species of fish (10 species of fish were observed or captured during 2013 baseline studies). Tatelkuz Lake will be the source of make-up water for Davidson Creek IFN via discharge from the FWR and is located downstream of Creek 661 which will receive discharge from a SCP during Construction phase and seepage from the TSF in Operations (or Closure and Post-closure, which will be addressed in a future amendment to the AEMP plan). Tatelkuz Lake has been classified as a Class I waterbody for the purposes of the YDWL.

4.1.6 Creek 705

The Creek 705 watershed is a sub-watershed of the Fawnie Creek watershed. Creek 705 is a third order stream on the western side of Mount Davidson, flowing into Fawnie Creek approximately 8 km downstream of Top Lake. Creek 705 watershed contains a moderately-sized lake (Lake 1538) near the headwaters of the southern drainage, and receives flow from a number of small tributaries in the middle to upper watershed. The main northern basin in the upper part of the watershed is drained by Creek 606013 through a headwater lake (Lake 1428).

There will be no Project infrastructure or mining facilities located in the Fawnie Creek watershed and no discharge or seepage is predicted to report to this watershed and Creek 705 sampling locations are considered reference locations for most AEMP components. However, minor changes in flow to Creek 705 may occur as result of the surface runoff diversions; thus, for the purpose of the AEMP, Creek 705 is considered an impacted site for the hydrology component only. Creek 705 has not received a classification for YDWL purposes.

4.1.7 Fawnie Creek Tributary

Fawnie Creek is located approximately 10 km northwest of the Blackwater deposit. The creek flows southwest to join the Entiako River, which flows into the Nechako Reservoir. There will be no Project infrastructure or mining facilities located in the Fawnie Creek watershed. Thus, Fawnie Creek sampling locations are considered reference locations. Baseline aquatic resource sampling has occurred on a tributary of Fawnie Creek (see Figure 3.1-1 and 3.3-1) and the sampling location will be consistent with the proposed monitoring site. Fawnie Creek has not received a YDWL classification.

4.1.8 Matthews Creek

Matthews Creek is located southwest of the Project within the Fawnie Creek watershed. Creek 705 combines with Fawnie Creek and flows towards Laidman Lake and joins with Matthews Creek. There will be no Project infrastructure or mining facilities located in the Fawnie Creek watershed and hydrology sampling location located on Matthews Creek is considered a reference location. Matthews Creek has not received a YDWL classification.

4.1.9 Kuyakuz Lake

Kuyakuz Lake is located approximately 20 km southeast of the Project and sampling locations located at Kuyakuz Lake are considered reference locations as it is upstream of potential Project influences. The lake has a surface area of 820 ha, a volume of 63 Mm^3, a mean depth of 7.7 m, and provides spawning and overwintering habitat for fish. Kuyakuz Lake has not received a YDWL classification.

4.2 Locations, Timing, and Frequency of Sampling under the AEMP

The proposed stream and lake sampling locations for the AEMP and the rationale for their selection are outlined in Table 4.2-1. Sample locations were selected based on a gradient design and include near-field (closest to the mine site), mid-field, and far-field sites (furthest downstream of the mine site), in addition to within stream reference sites and regional reference sites where no Project-related effects are anticipated.

Table 4.2-1: AEMP Stream and Lake Sampling Locations and Rationale

Watershed	Site ID	Easting	Northing	Type of Site	Rationale
Streams					
Davidson Creek	DC-05	378205	5899299	near-field impact site	FWR reservoir discharge, SCP discharge, seepage,
	DC-10	378855	5900126	near-field impact site	SCP discharge, downstream of FWR reservoir, seepage
	DC-15	381880	5904065	near-field impact site	downstream of FWR and SCP discharge, seepage
	DC-20	384244	5907733	mid-field impact site	downstream of FWR reservoir, seepage
Turtle Creek	TC-01	369772	5902753	reference site	upstream site (not impacted)
	TC-05	374261	5903206	near-field impact site (Creek 700)	downstream of airstrip (potential surface run-off)
	TC-10	378796	5906055	mid-field impact site	downstream of airstrip (potential surface run-off)
	TC-15	383023	5908521	mid-field impact site	downstream of airstrip (potential surface run-off)
Creek 661	661-01	381129	5897914	reference site (hydrology)	upstream site (not impacted)
	661-05	378894	5897037	near-field impact site	seepage
	661-10	381255	5897993	near-field impact site	SCP discharge, seepage
	661-20	388707	5899424	mid-field impact site	downstream of SCP discharge, seepage
Chedakuz Creek	CC-01	398132	5889857	reference site (kokanee spawning only)	upstream site (not impacted)
	CC-03	388667	5899132	reference site (water quality only)	upstream site (not impacted)
	CC-05	390399	5901047	mid-field impact site	downstream of FWR reservoir, seepage
	CC-10	385401	5907627	mid-field impact site	downstream of FWR reservoir, seepage

Watershed	Site ID	Easting	Northing	Type of Site	Rationale
	CC-12	385080	5908171	mid-field impact site (hydrology only)	downstream of FWR reservoir, seepage
	CC-15	383937	5909423	mid-field impact site	downstream of FWR reservoir, seepage
	CC-20	383097	5910077	far-field impact site	downstream of FWR reservoir, seepage
	CC-30	375187	5916462	far-field impact site	downstream of FWR reservoir, seepage
	CC-40	368695	5918685	far-field impact site	downstream of FWR reservoir, seepage
Creek 705	705-05	365740	5894247	reference site	upstream site (not impacted)
	705-10	362275	5893055	reference site	upstream site (not impacted)
Fawnie Creek Tributary	FC-01	363830	5899354	reference site	upstream site (not impacted)
Matthews Creek	MC-05	358247	5886498	reference site (hydrology only)	upstream site (not impacted)
Lakes					
Kuyakuz Lake	KL-01	395187	5888710	reference site	upstream lake (not impacted)
Tatelkuz Lake	TL-01	387247	5905786	mid-field impact site	downstream of SCP discharge to Creek 661, seepage to Creek 661

Note: FWR = freshwater reservoir; SCP = sediment control pond.

In general, the sampling stations for the AEMP have been selected and grouped (Table 4.2-1) to enable the identification of Project-related effects (near-field sites, immediately downstream of the mine site in Davidson Creek or Creek 661), as well as mid- and far-field sites to enable identification of potential interactions of Project effects with other, non-Project related effects (e.g., cumulative effects, such as from logging or agricultural activities). If changes in the aquatic environment are identified in mid- or far-field sites, but not at near-field sites, the changes are unlikely to be due to Project-related effects. If changes in the aquatic environment are identified in near-field sites, particularly the sites closest to the mine site, the changes are likely attributed to the Project. In this case, a gradient analysis (either statistically or through visual data exploration) will be completed to identify the extent of Project-related effects.

At each station sampling components have been selected based on likelihood and magnitude of potential impacts, suitability for sampling (i.e., aquatic resource or other in-stream sampling will not be completed in areas of kokanee spawning habitat to avoid causing damage or disruption to bed substrates), and the requirement for reference sites (Table 4.2-2; Figure 4.2-1).

Short-term (e.g., annual) water quality variability will be characterized with monthly water quality sampling conducted at stream locations expected to receive Project contact water (seepage) or discharge (i.e., discharge point or compliance point) and at one or two sites downstream of the discharge points (i.e., near-field impact sites) (Table 4.2-2 and Table 4.2-3). Quarterly sampling of water quality at mid-field and far-field impact sites will be completed to capture variability during both the ice-covered season (November and February) and open-water season (May and August). There will also be a “5-in-30” water quality sampling (referred to as “weekly” sampling, where 5 water samples are collected in a 30 day period instead of the monthly or quarterly sample) completed once in May/June, once in September/October, and once during the winter period (between November to March) at a subset of sites to characterize water quality during the most and least variable periods of the year (freshet, fall rains, and winter low flow). The weekly (5-in-30) sampling will be focused on Davidson Creek and Chedakuz Creek sites (Table 4.2-2).

Starting in Construction phase, the AEMP will initially be conducted annually for most sampling components (Table 4.2-3). However, certain components will be conducted annually initially with a framework to decrease sampling frequency by one year after each three-year period in which no effects are identified, to a minimum sampling frequency of once every three years (components shown as "annual for the first three years" in Table 4.2-3). Once sampling frequency is decreased to once every two or three years, frequency would be increased again by one year if effects were identified, up to a maximum frequency of annually. Components that will be sampled under this variable frequency framework are: 5-in-30 water quality, surface water toxicity testing, sediment quality, aquatic resources (periphyton and benthic invertebrates), and fish inventory (Table 4.2-3).

For fish tissue, once Construction phase begins sampling frequency will be once every three years. However, sampling frequency will be decreased to once every six years after two successive cycles in which no effects are identified. Once sampling frequency is decreased to once every six years, frequency would be increased again to once every three years if effects were identified. The adaptive management framework (Section 6.2.5) for fish tissue also allows for additional sampling to be added or adjusted, both in terms of sampling frequency and locations, when warranted to identify magnitude, spatial extent, or reversibility of observed Project-related effects. These sampling frequencies are consistent with those used by other mining projects in BC, are consistent with the fish tissue sampling requirements under the MDMER, and would minimize the potential for causing adverse effects to fish populations due to the monitoring program (i.e., cumulative loss of individuals from the populations through lethal sampling).

Rainbow trout spawning surveys and kokanee spawning surveys and escapement surveys will be completed on an annual basis (Table 4.2-3) for at least the first eight years of Operations, to ensure that two complete kokanee cohort generations are assessed. Beyond the eight-year mark, spawning survey frequency could be reduced to once every two years, if no trend (changes) in fish community is observed.

4.3 Hydrology (Surface Water Quantity)

4.3.1 Measurement and Assessment Endpoints

Stage is converted to streamflow estimates using an empirical stage-discharge relationship (a rating curve; Table 4.3-1). Temporary or permanent changes in a rating curve can occur when the hydraulic control that defines the rating relationship changes. Rating curves for each station are constructed using rating measurements collected during each year of monitoring in order to assess the overall stability of hydraulic conditions in the channel. Discharge hydrographs will be generated for each hydrology station to assess freshet flows (timing and volume) in addition to flows driven by rainfall events, and flows sustained by groundwater inflows (Table 4.3-1). Annual unit runoff at stations will be assessed within each of the five major catchments:

- The Davidson Creek catchment, consisting of DC-05 and DC-15.
- The Turtle Creek catchment, consisting of TC-10.
- The Creek 661, Tatelkuz Lake, and Chedakuz Creek catchments, consisting of 661-01, 661-10, CC-10, CC-12, and CC-15, plus CC-30 and CC-40 spot measurements.
- The Creek 705 and Matthews Creek catchments, consisting of 705-10 and MC-05.

Unit runoff will be used to assess the hydrologic trends within and between the watersheds and how trends compare to baseline and water balance model predictions to assess Project related effects. Observed mean monthly streamflow for each station and the calculated change in monthly flow from baseline will be compared to water balance model predictions (Section 5.3 in Chapter 5 [Modelling, Mitigation, and Discharges]).

Table 4.2-2: Aquatic Effects Monitoring Program Stream and Lake Sampling Scheme

Watershed	Station ID	Hydrology[1]	Water Temperature	Water Quality			Fish Spawning or Escapement Survey			Sediment Quality	Water Toxicity Testing	Aquatic Resources[3]	Fish Inventory and Tissue
				Monthly	Quarterly	5-in-30[2]	Rainbow Trout Spawning	Kokanee Spawning	Kokanee Escapement				
Streams													
Davidson Creek	DC-05	✓	✓	✓	-	✓	-	-	-	✓	✓	✓	✓
	DC-10	✓ (spot)	-	✓	-	-	-	-	-	-	-	-	-
	DC-15	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓
	DC-20	-	-	✓	-	-	✓	✓	✓	-	-	-	-
Turtle Creek	TC-01	-	-	✓	-	-	-	-	-	✓	-	✓	✓
	TC-05	-	-	✓	-	-	-	-	-	✓	-	✓	✓
	TC-10	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓
	TC-15	-	-	-	✓	-	✓	-	-	-	-	-	-
Creek 661	661-01	✓	✓	-	-	-	-	-	-	-	-	-	-
	661-05	-	-	✓	-	-	-	-	-	✓	-	✓	✓
	661-10	✓	✓	✓	-	✓	-	-	-	✓	✓	✓	✓
	661-20	-	-	-	✓	-	✓	✓	✓	-	-	-	✓
Chedakuz Creek	CC-01	-	-	-	-	-	-	✓	✓	-	-	-	-
	CC-03	-	-	✓	-	✓	-	-	-	-	-	-	-
	CC-05	-	-	-	✓	✓	-	✓	✓	-	-	-	-
	CC-10	✓	✓	✓	-	✓	-	-	-	-	-	-	-
	CC-12	✓	✓	-	-	-	-	-	-	-	-	-	-
	CC-15	✓	✓	-	✓	✓	-	✓	✓	-	-	-	-
	CC-20	-	-	✓	-	✓	-	-	-	-	-	-	-
	CC-30	✓ (spot)	-	-	✓	✓	-	-	-	-	-	-	-
	CC-40	✓ (spot)	-	-	✓	✓	-	-	-	-	-	-	-
Creek 705	705-05	-	-	✓	-	-	-	-	-	✓	-	✓	-
	705-10	✓	✓	✓	-	✓	-	-	-	✓	✓	✓	✓
Fawnie Creek Tributary	FC-01	-	-	✓	✓	-	-	-	-	✓	✓	✓	✓
Matthews Creek	MC-05	✓	✓	-	-	-	-	-	-	-	-	-	-
Lakes													
Kuyakuz Lake	KL-01	-	-	-	✓	-	-	-	-	-	-	-	✓
Tatelkuz Lake	TL-01	✓	✓	-	✓	-	-	-	-	-	-	-	✓

Notes:

Dashes indicate sampling component is not completed at that site.

[1] A continuous hydrology monitoring station will be installed at selected locations unless indicated as spot measures (see Section 4.3).

[2] 5-in-30 water sampling refers to the collection of 5 water samples in 30 days during spring freshet, fall rains, and winter low flow periods and replaces the monthly or quarterly sample during the three months when the 5-in-30 samples are collected.

[3] Aquatic resources includes primary producer sampling (Section 4.6), and benthic invertebrate sampling (Section 4.7).

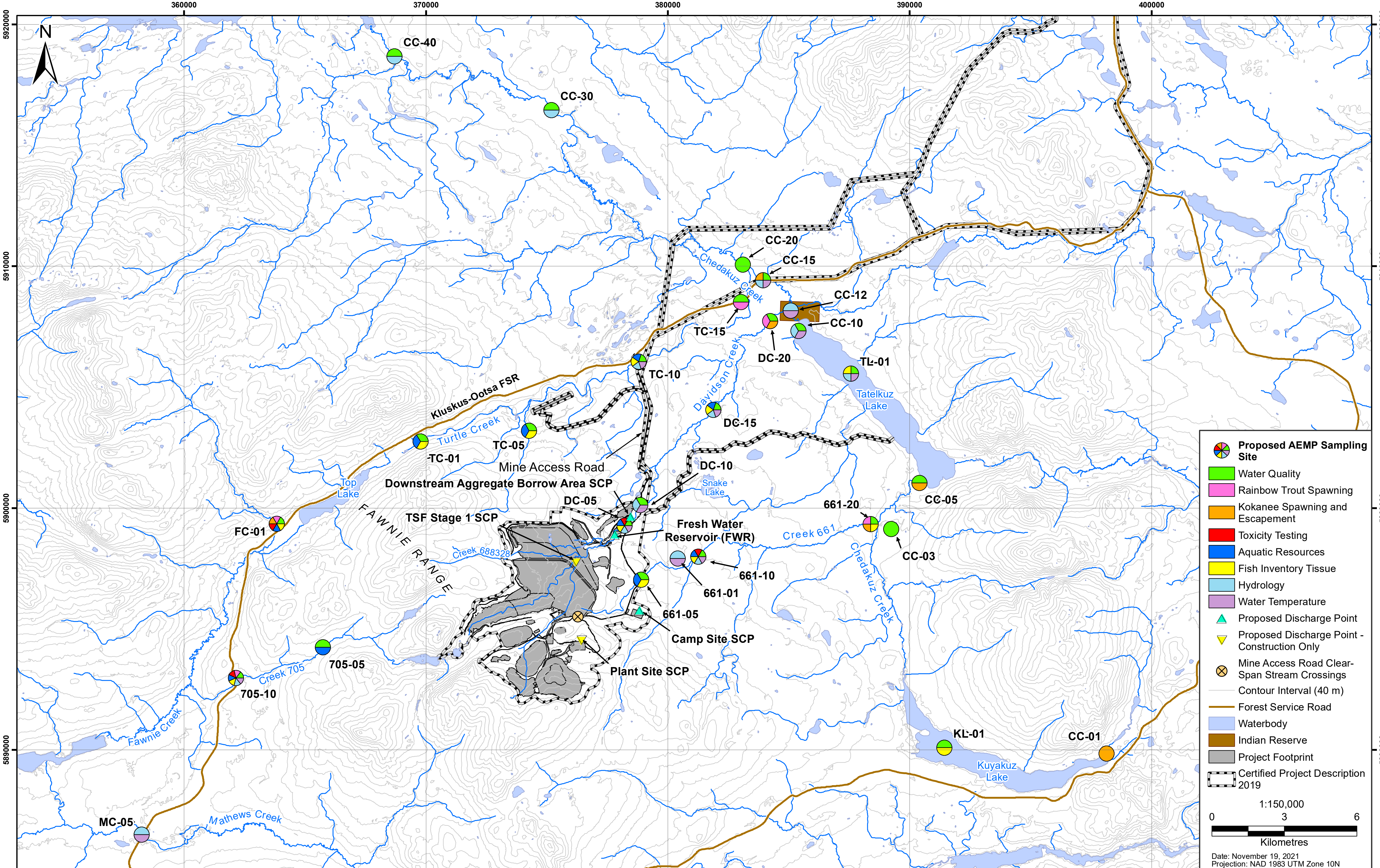

Figure 4.2-1: Aquatic Effects Monitoring Program Stream and Lake Sampling Locations

Table 4.2-3: AEMP Sampling Frequency and Replication

Monitoring Component	Annual Frequency	Monthly Frequency or Time of Year	Replication and Depths at Each Stream/Lake Sampling Event
			Streams
Automated hydrometric stations	annual	installation prior to freshet, continuous data downloaded each site visit	n = 1
Manual flow measurements	annual	spot measurements	n = 1
Water temperature	annual	continuous data downloaded biannually	n = 1
Water quality	annual	monthly	n = 1, 10% duplication in each water quality sampling event
	annual	quarterly	n = 1, 10% duplication in each water quality sampling event
	annual for the first three years	weekly (5 samples in 30 days, called 5-in-30) samples during freshet, fall rains, and winter	n = 5, 10% duplication in each water quality sampling event
Surface water toxicity	annual for the first three years	late August to early September	n = 1
Sediment quality	annual for the first three years	late August to early September	n = 5, 10% split samples
Periphyton	annual for the first three years	late August to early September	n = 5
Benthic invertebrates	annual for the first three years	late August to early September	abundance, n = 1 taxonomy, n = 1
Fish community – summer inventory of the fish community	annual for the first three years; tissue metal once per three years	after late July or early August	age and tissue metal, n = 8 rainbow trout
Fish community – kokanee summer spawning survey	annual for the first eight years	mid July to late September	selected 500 m reach of stream
Fish community – kokanee escapement survey	annual for the first eight years	early spring (freshet)	selected 500 m reach of stream
Fish community – rainbow trout spring spawning survey	annual for the first eight years	late May to late June	selected 500 m reach of stream

Monitoring Component	Annual Frequency	Monthly Frequency or Time of Year	Replication and Depths at Each Stream/Lake Sampling Event
Lakes			
Water Level	annual	Installation prior to freshet, continuous data downloaded each site visit	n = 1
Water Quality	annual	quarterly	n = 3 (surface and mid-depth, near bottom), 10% duplication at each sampling event
Fish tissue – rainbow trout, mountain whitefish, and kokanee	annual for the first three years; tissue metal, once per three years	late August to early September	age and tissue metal content: n = 8 adult fish per species

Table 4.3-1: Measurement and Assessment Endpoints for Hydrology

Measurement Endpoint	Assessment Endpoint
Rating Curve	Streamflow
Discharge Hydrograph	Freshet, summer, and winter discharge Mean monthly discharge Annual runoff

Potential changes in streamflow were predicted in Davidson Creek, Creek 661, Chedakuz Creek, and Creek 705 as a result of water diversions, alteration of watershed areas (and subsequent runoff volumes), and capture of run-off by various infrastructure components required for the Project (see Appendix 5.1.2.6D in New Gold 2015). Thus, IFN have been developed for Davidson Creek to address potential effects on fish and fish habitat. During all phases of the Project, streamflow will be monitored to maintain the IFN in Davidson Creek as defined in Appendix 5.1.2.6D in New Gold (2015), unless otherwise authorized by Fisheries and Oceans Canada (as per DS Condition 3.8; see also Section 5).

4.3.2 Sampling Locations and Methods

4.3.2.1 Automated Stations

The hydrometric program will consist of automated hydrometric stations at 12 stream sites and 1 lake site to collect continuous stage data throughout the year (Tables 4.2-2 and 4.2-3; Figure 4.2-1). The hydrology monitoring stations consist of a pressure transducer installed inside a protective aluminum pipe on the bank of the creek or lake and wired to a micrologger in a protective case, which is installed on a nearby tree. Stations are typically removed each year during the winter months to avoid damage to the sensor from ice (see bullet list below for exceptions). The station is then re-installed during the start of the open water season, when it is safe to do so. The pressure transducers continuously record water levels at fifteen-minute intervals.

Station DC-05 (formerly called station H2B) in upper Davidson Creek was installed in February 2018 is considered the point of compliance at which water flows are expected to meet permit conditions (i.e., Davidson Creek IFN). This station will be an eventual replacement for the former H2, which will be removed during the construction of the ECD, as per the 2020 PFS Design (Artemis 2020).

The AEMP hydrology stations with details on installation dates, locations and former station names from baseline studies for each of the stations are as follows:

- DC-10 (no former station, new site) in upper Davidson Creek: spot measurements between hydrology stations to confirm flows for IFN monitoring.
- DC-15 (formerly called station H4B) in middle Davidson Creek: H4B was installed in May 2012 to replace station H4 (decommissioned in 2011 and was located approximately 4 km downstream of H4B).
- TC-10 (formerly called station H6) in Turtle Creek: installed in April 2012, decommissioned in October 2014, and recommissioned in October 2017.
- 661-01 (formerly called station H10) in Creek 661: installed in May 2012, decommissioned in October 2014, and recommissioned in March 2019.
- 661-10 (formerly called station H1) in Creek 661: installed in May 2011 at the outlet of a culvert below the forest service road (FSR).
- CC-10 (formerly called station L1-Outlet) at outlet of Tatelkuz Lake: installed in May 2012 to monitor lake outflow (stage is measured at L1).
- CC-12 (no former station, new site): station will be installed in 2021 to monitor streamflow in Chedakuz Creek between the outlet of Tatelkuz Lake and the confluence with Davidson Creek. The station will remain operational year-round as the site often experiences open water conditions throughout the winter.
- CC-15 (formerly called station H5) in Chedakuz Creek: installed in April 2011 at the Kluskus FSR crossing. The station will remain operational year-round as the site often experiences open water conditions throughout the winter.
- CC-30 (no former station, new site) in lower Chedakuz Creek: spot measurements to correspond to the water quality station approximately midway between the confluence with Davidson Creek and the outlet of Chedakuz Creek at the Nechako Reservoir.
- CC-40 (no former station, new site) in lower Chedakuz Creek: spot measurements to correspond to the water quality station near the outlet of Chedakuz Creek at the Nechako Reservoir.
- 705-10 (formerly called station H7) in Creek 705: installed in May 2012 on Creek 705.
- MC-05 (formerly called station H12) in Matthews Creek: installed in May 2014 on Matthew's Creek to monitor streamflow. The station was decommissioned in October 2014 and recommissioned in February 2018.
- TL-01 (formerly station L1) in Tatelkuz Lake: installed in April 2012 to monitor lake levels.

4.3.2.2 Manual Flow Measurements

Standard techniques are employed at all hydrometric stations to manually measure streamflow. Measurements are taken throughout the open-water season to record a range of flows under different flow conditions. At each station, a minimum of five stage-discharge measurements are collected annually at different flow conditions in order to validate developed empirical relationships (rating curves) between water level (stage; h) and streamflow (discharge; Q). Discharge measurements will be collected during the winter months at monitoring stations where site conditions allow (typically late October to early April). For each station, these rating curves are then used to convert continuous stage data into continuous streamflow and, from this information, specific hydrologic parameters such as runoff and unit yield are calculated.

Manual streamflow measurements require either measuring water velocity and depth at intervals along a cross-section of the stream or using dilution techniques. The depth-velocity measurement method uses the cross-sectional area of the stream (m^2) and the velocity of the water (m/s) to compute flow (m^3/s). Dilution techniques calculate flow using a known volume injection (typically salt or Rhodamine WT) and continuously measuring the concentration downstream. Streamflow can be calculated using the measured concentrations data. One of three different techniques will be used to collect discharge measurements:

1. Measurements are collected using a hand-held electromagnetic current meter (Marsh-McBirney Flo-Mate 2000, Hach FH950 Flow Meter, or equivalent). At each gauging location, a minimum of 20 velocity and depth measurements are typically obtained across the stream cross-section. In some cases, during low flow conditions, the channel width may be narrower and the number of measurements obtained is less than 20. Velocity measurements are collected at 60% of the flow depth, which is generally accepted as representing the mean velocity of the vertical water section (Herschy 2009). When water depths are greater than 0.75 m, stream velocities are measured at 20% and 80% of the water depth, with the mean of the two readings taken to represent the mean velocity for the vertical. At each vertical water section, a mean velocity is calculated over a measurement time of 40 seconds to represent the flow conditions.
2. If streamflow is too high to allow for safe wading, or conditions are too turbulent, an Acoustic Doppler Current Profiler (ADCP) will be used. This method also makes use of the velocity-area technique. The ADCP is engineered to float on the water surface and is pulled across the channel on a tethered rope. It uses Doppler technology to measure high-resolution depth and velocity data.
3. If an ADCP cannot be used for any reason, an alternate means of measuring streamflow will be employed. For example, the dilution technique may be employed using a Rhodamine WT dye slug injection. Velocity is assessed by measuring the dye concentration as it travels downstream and a travel time-distance curve can be generated.

During each site visit, the stage will be determined independently of the data logger record either from reference mark observations or by surveying the water level from the station benchmarks. Typically, at least two discharge measurements will be taken during each site visit, and if the stage remained constant throughout the visit, the average of the two discharges will be used in the delineation of the rating curve.

4.3.2.3 Benchmarks

Benchmark surveys were conducted during the establishment of each monitoring station and will be done at the start and end of each open water season. For each hydrometric station, the elevation of the pressure transducer is surveyed relative to a local arbitrary datum established through surveying of locally installed benchmarks. The benchmarks and datum are used to maintain elevation control at each station. This allows the accuracy and precision of the transducers to be assessed, for continuity between years of monitoring, and increases simplicity in rating curve development. Surveying the stations relative to local benchmarks also allows the transducers to be moved as required while maintaining accuracy and precision in data collection.

Simultaneous to streamflow measurements, hydrometric levelling surveys will be completed and the water levels measured by the pressure transducers will be checked and compared to surveyed water levels and the established benchmarks at the site. Surveys are completed using an engineer’s rod and level to check whether any change in the position or drift of the transducer signal has occurred.

4.3.2.4 Staff Gauge Surveys

A vertical staff gauge can be an alternative or in addition to the benchmark survey. The vertical staff gauge is used as a reference gauge to which the pressure transducer is set. The staff gauges are 1 m sections of enamelled steel plate accurately graduated to 0.01 of a metre with each decimetre numbered. The gauge is read to the nearest millimeter, if possible, with maximum and minimum values recorded over a 10 second interval to account for high flows, turbulent water, or windy conditions that may cause fluctuations in the water level. The staff gauge is surveyed into the local station datum using the benchmarks as described in Section 4.3.2.3. The staff gauge water level reading is used to correct recorded pressure transducer water level to the local station datum by calculating the difference (offset) in value between staff gauge water level value (corrected to the local datum) and the pressure transducer water level.

4.3.3 Quality Assurance and Quality Control

The hydrometric data collected for the Project will be reviewed by a qualified Hydrometric Data Reviewer in general accordance with the “Standard Process for Review of Hydrometric Data”, as detailed in the *Manual of British Columbia Hydrometric Standards* (RISC 2018). Information regarding all aspects of the Project hydrometric monitoring field program is currently recorded and documented on KP’s FULCRUM online data management system and is reviewed for quality and completeness. Data are available for remote viewing by external agencies at the approval of BW Gold. In future, BW Gold may establish its own data management system.

In accordance with the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (BC MOE 2016a) the following information will be documented as part of the hydrology analysis Quality Assurance and Quality Control (QA/QC):

- Error bounds of instruments, data loggers, conversion factors, rating curves, and other data or equipment, as required;
- Operational limits of sensors (e.g., performance in sub-zero temperatures);
- Sensor drift and correction procedures;
- Benchmark surveys and shift corrections;
- Sensitivity analyses;
- Chronological record of field visits, maintenance, and calibration programs; and
- Whether discharge data have been estimated by extrapolating beyond measured discharge on the rating curve (may introduce error at the low and high ends of the curve).

Uncertainty exists in the measurement of both water level and discharge recorded as part of a hydrometric program. Water level uncertainty primarily arises from wave action above the water level sensor and is positively correlated to the magnitude of discharge (e.g., larger water level uncertainties exist at higher flows). Uncertainties may also arise from other factors such as winter conditions and beaver activity. An estimate of the variability in the true water level will be recorded during each site visit to document this uncertainty. This estimate is determined during the reading of the water level from the reference mark or during a benchmark survey and will be considered when determining the rating curve for each station.

Uncertainty in the manual discharge measurements will also be recorded during each site visit when discharge was recorded. Discharge uncertainty is estimated based on the characteristics of the measurement cross-section, the percent discharge recorded in each flow column, and the variability in calculated discharge between multiple measurements recorded during a single site visit. Discharge uncertainty will be presented graphically as error bounds on the rating curve figures.

The water level sensors installed for the Project will operate in a water depth up to 4 m and in temperatures ranging from 0 ºC to 50 ºC. Considering that air temperatures routinely drop below -5 ºC during the winter and that freezing of the sensor could cause pressures to exceed pressures equivalent to 4 m of water depth, the sensors are removed from stations that are likely to have very low flows during the winter months or are winterized to prevent freezing.

Sensor drift refers to the ability of electronic sensors to “drift” out of calibration. Sensor drift will be monitored at the Project stations by tracking the offset between gauge height determined from reading a staff gauge or reference mark and the water level recorded by the sensor. If the staff gauge or reference mark is determined to be stable over time (by conducting periodic benchmark surveys), and the relationship between gauge height and water depth measurement is found to linearly increase or decrease over time, the cause would most often be sensor drift.

4.3.4 Data Analysis

4.3.4.1 Rating Curves

A rating curve describes the relationship between water level (stage) and discharge at a single location in a stream. A rating curve was developed at each baseline monitoring station and was then applied to the respective continuous water level record to derive a continuous streamflow record for each station.
The stage-discharge rating curves are represented by an equation, or series of equations, of the form:

$$Q = C\ x\ (Stage - A)^n$$

Where Q is the discharge in cubic meters per second (m^3/s), C is a curve coefficient, *Stage* is the height of the water surface above an arbitrary site datum, A is an offset (frequently given as the stage of zero flow), and n is a curve exponent.

Each rating curve was matched to the measured data by manually fitting ‘visual-best-fit’ lines to the calibration data, with consideration of the physical conditions at each site and with the objective of minimizing the difference between the rating curve predicted discharges and the measured discharges. The hydraulic characteristics of the control section are also considered during the delineation of the rating curves. The basic form of the rating curve equation is based on general hydraulic theory pertaining to open channel flow, and the values of the coefficient and exponent are dependent on the hydraulic characteristics of the control section at the gauge, which provides a means of checking the validity of the derived equation (Maidment 1993).

4.3.4.2 Measured Discharge Records

Measured discharge records will be developed for each hydrology station by applying the rating curves to their respective stage records. Prior to application of the rating curves, the water level data are corrected to the station datum for all data collected during open water conditions, when the stage-discharge relationship was not altered by transient effects such as icing of the channel. The offset for water levels is based on the benchmark surveys completed throughout the period of record and the corrected water level data are referred to as stage data. Periods with erroneous water level data that could be due to ice effects, instrumentation malfunction, and sensor or clock drift, will be reviewed and corrected or removed from the data sets. Water level to stage corrections are calculated using the Aquarius™ or equivalent time series software, which allows for advanced data correction and correction tracking. Average daily discharge values are derived from the 15-minute record to produce daily discharge records for each station.

4.3.4.3 Estimated Winter Streamflow

Winter discharge is typically very low due to cold temperatures and freezing conditions. Measurements that are affected by ice are not used for rating curve development but are used to characterise winter streamflow. Estimated winter flow values are calculated using linear interpolation between winter discharge measurements to infill the gap between individual measurements. These estimated flows will be calculated when a sufficient number of measurements are made during a short period to estimate the hydrograph shape with some certainty. Winter flows are typically steady as they are primarily based on groundwater contribution and it is, therefore, reasonable for them to be predicted in this manner. The estimated winter discharge values will be added to the discharge records for each station.

4.3.4.4 Mean Monthly Discharge

Mean monthly discharge will be calculated for stations when there is at minimum least 20 days of discharge data during the month.

4.4 Surface Water

4.4.1 Surface Water Temperature

4.4.1.1 Measurement and Assessment Endpoints

Surface water temperature is an important characteristic of fish habitat. Temperature affects both the chemical and biological characteristics of surface water. It affects the dissolved oxygen concentrations of water, metabolic rates of aquatic organisms, and the sensitivity of these organisms to pollution, parasites, and disease.

Surface water temperature records will be developed for each of the temperature stations using the continuous monitoring data from each site and the in situ measurements recorded to verify recorded temperatures (Table 4.4-1). Temperature trends will be assessed for Project-related changes from baseline water temperatures. Water temperatures will be compared with daily streamflow from the nearest hydrology station to assess if trends are related to water flows and depth.

Table 4.4-1: Measurement and Assessment Endpoints for Surface Water Temperature

Measurement Endpoint	Assessment Endpoint
Surface water temperature – continuous	Station trends will be compared within creeks and to baseline trends Comparison to guidelines Before-after-control-impact (BACI) analysis

Predictions from the Application/EIS indicated that there will be changes in water temperature in Davidson Creek as a result of flow augmentation from the FWR (Section 5.3.3 of New Gold 2015). Thus, spatial comparison of average daily water temperatures at dedicated water temperature stations along Davidson Creek will be completed annually along with a comparison to baseline trends.

Station water temperatures will also be compared to the guideline optimal temperature ranges for life history stages of salmonids (BC MOE 2001a). Water temperatures in Davidson Creek, will be maintained in accordance with DS Condition 3.9 unless otherwise authorized by Fisheries and Oceans Canada (see also Section 5).

4.4.1.2 Sampling Locations and Methods

Water temperature monitoring will be conducted at hydrometric stations where the installed continuous monitoring hydrology station also collects water temperatures (Table 4.2-2). In addition, water temperature will be monitored at four dedicated water temperature stations installed in typical kokanee spawning habitat in the lower reaches of Davidson Creek (Figure 4.2-1). These stations consist of an Onset TidbiT v2 Temperature Data Logger or equivalent, held in the center of a short PVC pipe that is attached to a double concrete cinder block. The cinder blocks are placed horizontally on the creek bottom and together with the PVC pipe help shade the sensor from direct sunlight. Station names have suffixes “DEEP” or “KO”. DEEP indicates that stations are installed in a pool, near maximum pool depth, while KO indicates installation in a shallower riffle area. The DEEP and KO stations with the same “ST” number are sited together as a pair. The data loggers monitor water temperature year round.

4.4.1.3 Data Analysis

Annual water temperature records will be compiled and graphically presented to examine seasonal trends. Comparison to the nearest hydrology station discharge record will also be completed using graphical analysis to determine if trends are related to water flows and depth.

To assess if Davidson Creek water temperature changes may be related to the Project (i.e., discharge from the FWR) a before-after-control-impact (BACI) analysis will be completed (Table 4.4-1). The BACI is a standard method used to assess an environmental impact. The BACI analysis compares a before-after trend apparent at the potential impact sites with that at the corresponding reference site, to see if the trends are parallel and, thus, attributable to a natural process. A significant interaction for the *class* (impact versus reference) and *period* (before versus after) will be used to determine if a significant change in temperature has occurred.

It is hypothesized that if mine activities affected temperatures in surface water, then there would be a significant change in water temperature at near-field sites in comparison with background (baseline) concentrations or reference ranges. However, if a change in the trend is detected by the before-after comparison, but the BACI analysis indicates that a parallel change also occurred at the reference site (control versus impact), it is reasonable to conclude that this change could be a natural phenomenon or unrelated to the Project activities. Similarly, if a change is detected at mid- or far-field sites but not at near-field sites or the reference site, it is reasonable to conclude that this change is likely the result of non-Project activities (e.g., forestry or agricultural activities downstream of the Project and upstream of the sampling location).

4.4.1.4 Quality Assurance and Quality Control

All temperature data will be reviewed for erroneous readings, which can often occur when the temperatures have logged prior to the time that the sensor was installed. At most sites, sensors will be removed during the winter season to prevent damage and replaced prior to the onset of freshet.

In situ water temperature will be measured on a regular basis at each station using a YSI Pro Plus multiparameter probe or equivalent to verify sensor temperature readings. If the average differences between the in situ measurements and the logged data are within ± 0.5 ºC, the recorded data are not corrected (this value is based on analysis of 2015 to 2020 water temperature data indicating that the differences between the in situ measurements and the logged data were typically within ± 0.5 ºC; see Appendix 2-I, 2020 Hydrology and Water Temperature Baseline Report).

4.4.2 Surface Water Quality Sampling

4.4.2.1 Measurement and Assessment Endpoints

Surface water chemistry samples will be collected at sites downstream from the mine site and at reference sites, as indicated in Table 4.2-1 and Table 4.2-2. Surface water chemistry will be evaluated with one or more assessment endpoints including comparison to water quality guidelines for the protection of freshwater aquatic life (BC ENV 2019a, 2021, CCME 2021a), approved Science-based Environmental Benchmarks (SBEBs), the YDWL water quality standards, background (baseline) or reference ranges, and/or BACI analysis (Table 4.4-2).

Table 4.4-2: Measurement and Assessment Endpoints for Surface Water Quality

Measurement Endpoint	Assessment Endpoint
Surface water chemistry	Comparison to BC or CCME WQG (BC 2019a, 2021; CCME 2021a), approved SBEBs, or Yinka Dene Water Law water quality standards Comparison to background or reference ranges[1] Before-after-control-impact (BACI) analysis[2]

Notes:

[1] For in situ water quality parameters: temperature, pH, conductivity, turbidity, and dissolved oxygen.

[2] For water quality parameters analyzed at the laboratory: total suspended solids, pH, alkalinity, radium-226, total phosphorus, ammonia-N, nitrate-N, nitrite-N, chloride, fluoride, sulphate, cyanide (total and WAD), total metals including aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, and zinc; dissolved metals including aluminum, cadmium, calcium, copper iron, manganese, and zinc.

4.4.2.2 Sampling Locations and Methods

Field Methods

Stream sample locations will be completed at water quality stations identified in Table 4.2-2 and Figure 4.2-1. Generally, sampling will be conducted monthly at sites closest to the mine site and quarterly at sites further away from the mine site. In addition, 5-in-30-day sampling will be done at a subset of sites in place of the monthly or quarterly samples in spring freshet, fall rains, and winter low flow. Water sampling will be completed to align with biological sampling, at the same sites and timing (Tables 4.2-2 and 4.2-3).

Sampling methods will follow best practices as outlined in *British Columbia Field Sampling Manual* (BC MWLAP 2013). Samplers will always practice clean sampling techniques including wearing clean vinyl gloves while handling samples at each station.

For stream sampling, water samples will be collected in areas of laminar flow (if present and when it is safe to do so) to avoid suspended particulates. Stream samples will be collected by facing upstream and submerging the laboratory-certified, clean general parameter sample bottle below the surface until filled. The general parameter bottle will then be used to fill the other sample bottles by decanting the collected water.

Two lakes will be sampled (Tatelkuz Lake and Kuyakuz Lake; Table 4.2-2; Figure 4.2-1). In situ profiles of dissolved oxygen, pH, conductivity, specific conductivity, and temperature at approximately 1 m intervals will also be completed. When the lake is thermally stratified (indicated by the water column profile) sampling depths will include above and below the thermocline. In situ water will be measured at each stream site and water column profiles (i.e., temperature, conductivity, and dissolved oxygen) will be measured at each lake site using a calibrated multi-parameter meter (e.g., YSI Professional Plus).

For lake chemistry samples, discrete samples will be collected at three depths (shallow, middle, and bottom) in the water column during the open-water season using an acid washed Van Dorn water sampler or similar (e.g., Kemmerer). Sampling locations at each lake will be located at the deepest point in the lake basin (as determined during baseline bathymetric surveys) and accessed by boat, if safe to do so depending on conditions.

All samples will be field filtered and/or preserved in the field according to the analytical laboratory protocols. Samples will be stored in coolers on ice and/or refrigerated until shipped to an accredited analytical laboratory for sample analysis.

Laboratory Methods

Water quality samples will be collected for analysis of general physical/ion parameters, nutrients and organics, cyanide, and total and dissolved metals at a Canadian Association for Laboratory Accreditation (CALA)-accredited laboratory. The water quality parameters to be analysed using standard practices. Targeted detection limits for parameters will be at least 10 times lower than water quality guidelines or standards, where available, consistent with recommendations in BC ENV (2016a). Parameter to be analyzed are provided in Table 4.4-3.

Quality Assurance and Quality Control

The QA/QC principles will follow those outlined in guidance documents throughout the field sample collection and laboratory analysis phases (BC MOE 2016a; Environment Canada 2012; ENV 2013, 2020). Standard QA/QC practices to be incorporated include: water quality samples will be collected by qualified personnel using suitable sampling equipment (e.g., acid-rinsed sampling bottles and samplers); Chain-of-Custody (COC) forms will be used to track the samples; and analyses will be conducted by an accredited laboratory.

Table 4.4-3: Analyzed Water Quality Parameters

Physical Parameters and Dissolved Anions	Nutrients/Cyanides/Organic Carbon	Metals (Total and Dissolved)	
▪ pH (field and laboratory) ▪ temperature (field) ▪ turbidity (field and laboratory) ▪ conductivity (field and laboratory) ▪ dissolved oxygen (field) ▪ total dissolved solids ▪ total suspended solids ▪ hardness (as $CaCO_3$) ▪ total Alkalinity (as $CaCO_3$) ▪ acidity (as $CaCO_3$) ▪ bromide ▪ chloride ▪ fluoride ▪ sulphate	▪ ammonia (as N) ▪ nitrate (as N) ▪ nitrite (as N) ▪ Total Kjeldahl Nitrogen ▪ total phosphorous ▪ ortho-phosphorous ▪ total cyanide ▪ cyanide, Weak Acid Dissociable ▪ thiocyanate ▪ total organic carbon ▪ dissolved organic carbon	▪ aluminum ▪ antimony ▪ arsenic ▪ barium ▪ beryllium ▪ bismuth ▪ boron ▪ cadmium ▪ calcium ▪ chromium ▪ cobalt ▪ copper ▪ iron ▪ lead ▪ lithium ▪ magnesium	▪ manganese ▪ mercury ▪ molybdenum ▪ nickel ▪ potassium ▪ selenium ▪ silicon ▪ silver ▪ sodium ▪ strontium ▪ thallium ▪ tin ▪ titanium ▪ uranium ▪ vanadium ▪ zinc

The QA/QC for measurement of field (in situ) parameters include daily calibration of the meter before use, as per the manufacturer’s manual and recorded in a calibration log. The meter will be allowed to stabilise before taking each reading and the data will be reviewed for unreasonable values.

In addition, QA/QC samples will be collected and include field blanks, travel blanks, blind field duplicates, and equipment blanks. Field blanks are empty sample bottles filled with deionised water at randomly selected stations to assess potential contamination from the surrounding environmental conditions (e.g., aerial particulates) and sample handling techniques. Travel blanks are pre-filled by the analytical laboratory and are not opened in the field to assess potential contamination from travel, storage, or from the laboratory handling. Blind field duplicate samples will be collected in the field at randomly selected stations and submitted to the laboratory to provide an indication of the variability inherent in field sampling (i.e., environmental heterogeneity). Equipment blanks are sample bottles filled with deionised water collected from the cleaned and rinsed sampler to provide an indication of decontamination or potential contamination from the sampling equipment.

A minimum of one field blank and one travel blank will be collected per sampling event, field duplicates will be collected to account for approximately 10% of the total number of samples collected, and equipment blanks are collected for each cleaned-sampler used to collect water.

Detected concentrations of water quality parameters (concentrations above the MDL) will be noted for both travel and field blanks to indicate possible contamination.

For each pair of QA/QC field duplicate water samples, the relative percent differences (RPD) will be calculated, where:

$$RPD = 100\% \times \left(\frac{|replicate\ 1 - replicate\ 2|}{\frac{replicate\ 1 + replicate\ 2}{2}} \right)$$

The RPD between the duplicates is a measure of the variability inherent in field sampling (environmental heterogeneity, sampler handling leading to contamination, potential laboratory errors). Water quality parameters where one or both values were less than five times the MDL are not included in the RPD calculations because variability near the MDL is too high (BC MWLAP 2013). The *British Columbia Field Sampling Manual Part A Quality Control and Quality Assurance* (BC MWLAP 2013) recommends that any field duplicates with RPD values exceeding 20% should be noted and data should be interpreted accordingly. The results of RPD calculations are examined to detect patterns of high variation for multiple parameters within sample pairs, indicating possible contamination during field sampling.

Both field and water quality observations will be examined for their expected range of values and/or previous results. Based on statistical metrics and professional judgement, outliers indicating an error will be removed. A combination of statistical metrics and/or criteria will be used to identify potential outliers (e.g., data points outside of the 95^{th} or 99^{th} percentile or statistical tests such as the Dixon (1950,1951) or Rosner (1975, 1983) test) along with graphical analysis (Gilbert 1987). Professional judgement will also be used to determine whether the data are likely to be outliers due to sampling or analysis errors or issues (e.g., unit errors in lab report, sample contamination), or whether the data represent the true extreme of natural or expected conditions (e.g., very high concentrations of total suspended solids and metals that may occur during a natural 1 in 100 storm event). As part of the AEMP reporting (Section 7), the method for identifying potential outliers and the rationale for excluding or including those data in analysis will be provided in the AEMP report.

Laboratory QA/QC measurements and protocols will be completed to determine and confirm the accuracy, sensitivity, precision, and comparability of the data. This will include the use of method blanks, replicates, laboratory control samples and reference material, and matrix spikes. Method blanks are clean control samples that detect potential contamination during sample preparation and analysis. Laboratory duplicates are field-collected samples split at the laboratory and analyzed separately. These determine the methodological precision. Accuracy will be tested using laboratory control samples, reference materials, and matrix spikes. Laboratory control samples are a clean matrix (i.e., distilled, de-ionized water) spiked with test parameters. Reference materials are samples with a known concentration of a parameter. Matrix spikes are field-collected samples that are spiked with test analytes. Anomalous results (for example, detected concentrations in the blanks) will be verified with repeated analysis.

4.4.2.3 Data Analysis

Data analysis and reporting will focus on the POPCs and POCs for the Project. Nitrite, fluoride, sulfate, total and dissolved aluminum, total cadmium, total chromium, total iron, and total zinc were identified as the POPCs in the CSM because their baseline or predicted concentrations were higher than 80% of the WQG-AL (Appendix 7-B). Nitrogen forms (nitrate, nitrite, ammonia), total phosphorus, and TDS were the water quality parameters identified as the Project-related special-case POCs for aquatic life in the CSM and dissolved aluminum was identified as a POC (Appendix 7-B). The CSM also recommended the inclusion of total mercury in monitoring due to uncertainties in the geochemical source terms used in water quality predictions (see Section 1.5.3). The list of evaluated parameters may be modified as part of the AEMP reporting to include other parameters if concentrations increase or are predicted to increase.

In addition to the POPCs and POCs, analysis of water chemistry will include constituents with available BC WQG-AL (ENV 2019a, 2021), federal WQG-AL (CCME 2021a), approved SBEBs or YDWL water quality standards (Table 4.4-2). A dissolved aluminum SBEB has been proposed for Davidson Creek and Creek 661 that is based on the background method (i.e., the SBEB is based on the seasonal 95th percentile + 20% of concentrations measured in Davidson Creek and Creek 661 prior to development of the Project; Lorax 2022). No Project-related effects to aquatic biota would be expected if the future concentrations of dissolved aluminum remain below the SBEB. Once approved, the dissolved aluminum SBEB would be used as the applicable benchmark in place of the BC WQG-AL.

For analysis and graphing purposes, parameter concentrations below the MDL will be assigned a concentration of half the reported MDL. Field duplicates will be treated as one sample represented by the average concentration of the replicate samples. For the purpose of visualization, weekly samples collected in one month (from 5-in-30 sampling) will be treated as one sample as a monthly mean concentration.

Potential effects of temperature, field pH, conductivity, turbidity, and dissolved oxygen will be assessed by graphical analysis for comparison to baseline and/or reference ranges (Table 4.4-2). Reference ranges will be defined as the 5th to 95th percentile concentrations from the baseline (background) or reference dataset. Since baseline data collection is ongoing for surface water quality, background and/or reference ranges will be defined and summarized in the first AEMP report and will be based on data collected prior to Project construction and data collected at reference sites.

Surface water chemistry for parameters with guidelines will be compared to available BC (ENV 2019a, 2021) or federal (CCME 2021a) WQG-AL (Table 4.4-2) or approved SBEBs. Comparisons of measured parameter concentrations to WQG-AL follows the hierarchy provided in *Technical Guidance 4: Annual Reporting under the Environmental Management Act* (BC MOE 2016b), with WQG-AL applied in the following order:

1. The most current BC Approved Water Quality Guideline (BC ENV 2019a) or approved SBEBs.
2. If no approved WQG-AL are available, use the most current BC Working Water Quality Guideline for British Columbia (BC ENV 2021).
3. If neither of these has yet been established, use the most current guideline provided by the CCME (2021a).

For pH-, hardness-, DOC-, and chloride-dependent WQG-AL, the sample-specific hardness, pH, DOC, or chloride values will be used to calculate the WQG-AL. Concentrations that are less than the MDL but greater than the applicable WQG-AL will be noted but excluded from WQG-AL exceedance calculations.

Long-term average (“chronic”) WQG-AL will be used for initial comparisons. Long-term WQG-AL are the most restrictive; consequently, if no exceedances of long-term guidelines are identified for a parameter, no further investigation is necessary. If exceedances of the chronic WQG-AL are noted, concentrations will also be compared to the short-term (“maximum”) WQG-AL, where available. Comparisons to the WQG-AL will be done for each sample or for the average of the five weekly (5-in-30) samples, as recommended by BC MOE (2016c).

Guideline exceedances will be characterized using two metrics:

- frequency of exceedance (i.e., how often the WQG-AL is exceeded, calculated from the number of measurements exceeding the WQG-AL as a percentage of the total number of measurements); and
- magnitude (factor) of exceedance (i.e., by how much the WQG-AL is exceeded, calculated from the average of parameter concentration, from the subset of concentrations greater than the WQG-AL divided by the WQG-AL).

The *Yinka Dene 'Uza'hné Surface Water Guide to Surface Water Quality Standards* (Nadleh Whut'en and Stellat'en 2016a) provides methods for the derivation of water quality standards for each of the classified water categories. Baseline water quality sampling has been completed at a number of potential attainment sites on Davidson Creek and Chedakuz Creek in recent years (including 2019 to 2021) to meet the YDWL sampling frequency (see Appendix 2-K, 2011 to 2020 Baseline Water Quality Report). The implementation of the YDWL is under discussion with the CSFNs; therefore, the use of the YDWL in the AEMP will be updated upon completion of the discussions.

To further assess Project-related effects on surface water quality a BACI analysis will be completed (Table 4.4-2). The BACI analysis introduces a class effect to a mixed model ANOVA, which is based on the classification of the waterbody or site as an exposure or a reference site. Analysis will be performed using the most recent R statistical computing package, or equivalent (e.g., R Core Team 2019). A significant interaction between the (time) period and class effects reveals whether any before (baseline) - after (Construction or Operations phases) change in the mean parameter concentration that occurred in the exposure site has not occurred in the reference site. The overall site (control versus impact) and period (before versus after) interaction significance (p-value less than 0.05) will be assessed using an F-test.

Data transformations (e.g., log transformation) will be completed if determined to be appropriate (i.e., random distribution of residuals). For all effects analyses, statistical results are considered unreliable if more than 70% of the values in the dataset for a parameter are below analytical MDLs (i.e., censored data).

To identify the sites and months that differ significantly, the mixed model ANOVA will also include the fixed effects of period (before versus after) and month, and a random effect of year to account for variability in water quality data. For the period effect, data will be grouped into one of two periods: before the start of construction (2011 to 2021) or after the start of construction (2022 onwards). To reduce the number of false positives (Type I error) due to the large number of statistical tests conducted, a reduced significance level (0.01) will be used when reviewing the results.

It is hypothesized that if mine activities affected surface water quality, then there would be a significant change in surface water quality at near-field impact sites in comparison with background (baseline) concentrations or reference ranges. However, if a change in the mean is detected by the before-after comparison, but the BACI analysis indicates that a parallel change also occurred at the reference site (control versus impact), it is reasonable to conclude that this change is likely a natural phenomenon or unrelated to the Project activities. Similarly, if a change is detected at mid- or far-field sites but not at near-field sites or the reference site, it is reasonable to conclude that this change is likely the result of non-Project activities (e.g., forestry or agricultural activities downstream of the Project and upstream of the sampling location).

Observations from the receiving environment monitoring sampling locations that were included as modelling nodes in the surface water quality predictive model will also be used to evaluate the assumptions integrated into the model (i.e., comparison of measured concentrations to modelled predictions). Monitoring locations that were also model nodes include (model node names in brackets): DC-05 (WQ28), DC10 (WQ27), DC-15 (WQ26), and DC-20 (WQ7) in Davidson Creek; 661-10 (WQ5) and 661-20 (WQCreek661) in Creek 661; and CC-10 (WQ8), CC-15 (WQ9), and CC-20 (WQ13) in Chedakuz Creek. Comparison of future measured concentrations to future predictions will be completed as part of the adaptive management response framework for surface water quality described in Section 6.2.1. Comparison of measured and predicted concentrations is also expected as part of Annual Reporting under the EMA Waste Discharge Authorization for effluent. Where the surface water quality model is found to over-predict or under-predict concentrations of parameters at a particular site, additional evaluation will be completed to identify if adjustments to the model are required. Over time, incorporation of additional Project-specific information and site understanding will result in refinement of the water quality model to improve the accuracy of future predictions.

4.4.3 Surface Water Toxicity Testing

4.4.3.1 Measurement and Assessment Endpoints

Surface water samples for the purposes of laboratory-based toxicity testing surface water toxicity will be assessed based on the calculation of the LC_x (lethal concentration that causes mortality in x% of test organisms) or the EC_x (effect concentration that causes effects in x% of test organisms), as shown in Table 4.4-4. The "x" is defined by the standardized Environment Canada methodologies (see Section 4.4.3.2)

Table 4.4-4: Measurement and Assessment Endpoints for Surface Water Toxicity

Measurement Endpoint	Assessment Endpoint
Surface water toxicity testing (growth, reproduction, or survival)	Calculation of LC_x or EC_x[1]

[1]*Test species for fish species: fathead minnow or rainbow trout; invertebrate species:* Ceriodaphnia dubia*; plant species:* Lemna minor*; and an algal species.*

4.4.3.2 Sampling Locations and Methods

Sublethal toxicity testing will be conducted using the following test methodologies, as defined in Schedule 5 (Environmental Effects Monitoring Studies) of the MDMER (Table 4.4-4):

- Fish species will be assessed using the *Biological Test Method: Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout)* (Environment Canada 1998);
- Invertebrate species will be assessed using *Biological Test Method: Test of Reproduction and Survival Using the Cladoceran* Ceriodaphnia dubia *(*Environment Canada 2007a*)*;
- An algal species will be assessed using *Biological Test Method: Growth Inhibition Test Using a Freshwater Alga (*Environment Canada 2007b*)*; and
- Plant species will be assessed using, *Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte*, Lemna minor (Environment Canada 2007c).

Surface water toxicity sample locations will be completed at near-field sampling stations downstream from the mine site (DC-05 in Davidson Creek and CC-10 in Creek 661) and at a reference site (705-10 in Creek 705) as shown in Table 4.2-2 and Figure 4.2-1. Surface water toxicity testing sampling must be co-collected with a sample for water chemistry analysis. This co-collection of samples is critical to the interpretation of the toxicity test results, in the event that the water causes adverse effects on laboratory organisms in the toxicity test. Samples for toxicity testing should also be collected during the same time of year as sampling under the AEMP for other biota (e.g., primary producers, invertebrates, and fish).

Toxicity testing will initially be completed once per year for a period of three years. If after three years, no effects are identified, testing frequency will be decreased by one year for each three-year period, to a minimum sampling frequency of once every three years (Table 4.2-2). If effects are identified while sampling is occurring at a reduced frequency, the frequency will be increased by one year.

4.4.3.3 Data Analysis

At the end of each laboratory-based test, the endpoint (e.g., growth, reproduction, or survival) is evaluated statistically to determine the LC_x (mortality) or EC_x (e.g., reproduction, growth).

The toxicity testing is based on a dilution series where the surface water sample is diluted in the lab and effects on exposed organisms are measured over time. The LC_x or EC_x concentration will be reported based on the dilution of water associated with the effect (i.e., concentrations reported in volume/volume percent, % v/v). When the undiluted water has no effect, the LC_x or EC_x is reported as greater than 100% v/v. These metrics are calculated by the laboratory using standard software and accepted methods (Environment Canada 1998, 2007a, 2007b, 2007c), and are typically reported with confidence intervals around the LC_x or EC_x.

Where the LC_x or EC_x is less than 100% v/v, it indicates that the tested sample can cause adverse effects to laboratory organisms and suggests that there is potential for toxicity to occur in the source waters. However, effects in a laboratory-based toxicity test does not necessarily mean that adverse effects will occur in source waters, as the types of organisms used in the tests may not fully represent those in the source waters (e.g., organisms in the source waters may have adapted to the conditions in ways that laboratory organisms are not). It is not unusual to find that natural, non-impacted surface waters (e.g., references sites) can cause adverse effects (a measurable LC_x or EC_x) in laboratory organisms.

Results of the surface water toxicity testing will be interpreted based on comparison between control (reference) and impact (downstream of the mine site) sites, as well as considering results of the co-collected water chemistry data. Results of effluent characterization at the final discharge point under Schedule 5 of the MDMER (i.e., analysis of effluent using the same tests listed in Section 4.4.3.2, as described in Appendix 9-E, MSDP) should also be considered in the interpretation of results of surface water toxicity testing.

Results of the toxicity testing are intended to be a supplemental line of evidence to other data collected under the AEMP and will not be used alone to identify Project-related effects in the receiving environment.

4.5 Sediment

4.5.1 Sediment Quality Sampling

4.5.1.1 Measurement Assessment Endpoints

Sediment quality samples will be collected at sites downstream from the mine site and at reference sites, as shown in Table 4.2-2. Sediment quality will be evaluated with one or more assessment endpoint: comparison to BC or CCME sediment quality guidelines for the protection of freshwater aquatic life (SQG-AL; ENV 2019a, 2021; CCME 2021b), background (baseline) or reference ranges, and/or BACI analysis (Table 4.5-1).

Table 4.5-1: Measurement and Assessment Endpoints for Sediment Quality

Measurement Endpoint	Assessment Endpoint
Sediment chemistry	Comparison to sediment quality guidelines for the protection of freshwater aquatic life (BC ENV 2019a, 2021; CCME 2021b) Comparison to background or reference ranges[1] Before-after-control-impact (BACI) analysis[2]

[1] For particle size and total organic carbon (parameters required as part of the benthic invertebrate surveys as per Schedule 5 of the MDMER).

[2] For parameters that have BC or federal sediment quality guidelines for the protection of aquatic life including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, and zinc.

4.5.1.2 Sampling Locations and Methods

Field Methods

Sediment quality samples will be collected from stream sites identified in Table 4.2-2 and Figure 4.2-1. Sampling frequency will initially be once per year, with sampling frequency decreased by one year for each three-year period where no significant effects are identified. The minimum sampling frequency is once every three years, occurring at the same time as other aquatic resource sampling (late August or early September; Table 4.2-2).

Sediment samples will be collected by spooning the top layer of the sediment (i.e., 3 to 5 cm deep) in depositional zones (i.e., areas of slow-moving water). Five replicates will be collected from distinct areas of each stream site (e.g., different stretches of the main channel) covering 50 to 100 m depending on stream size and site access. For each replicate, the subsamples (the spoon grabs) will be pooled in a clean plastic bowl until sufficient sample is collected. Excess water will be drained and the composite sample will be homogenized and transferred into a pre-labelled sample bag and sealed with no air bubbles. This process will be completed for each replicate. Samples will be stored in coolers on ice and/or refrigerated until shipped to a CALA-accredited analytical laboratory for sample analysis.

Laboratory Methods

Targeted detection limits for parameters will be at least 10 times lower than sediment quality guidelines or standards, where available, consistent with recommendations for other environmental media in BC ENV (2016a). Parameter to be analyzed are provided in Table 4.5-2.

Particle size analysis will be completed on the whole sediment sample. Metal and total organic carbon (TOC) analysis will be conducted on the fraction of the sample smaller than 63 µm (Table 4.5-2), as per guidance from the BC MOE (2016a). Results of metals analysis will be reported in dry weight.

Quality Assurance and Quality Control

The sediment quality QA/QC practices will follow those outlined in guidance documents during sample collection and laboratory analyses (BC MOE 2016a; Environment Canada 2012a; BC MWLAP 2013). All sediment quality samples will be collected by qualified personnel using suitable sampling equipment. Samples will be stored in appropriate containers and transported following accepted procedures. Chain-of-Custody forms will be used and the analyses will be conducted by a CALA-accredited external laboratory.

Table 4.5-2: Analyzed Sediment Quality Parameters

Physical Tests/ Particle Size/Carbon	Total Metals		
▪ moisture ▪ pH ▪ gravel (> 2 mm) ▪ sand (2 mm - 63 µm) ▪ silt (63 µm - 4 µm ▪ clay (< 4 µm) ▪ total organic carbon	▪ aluminum ▪ antimony ▪ arsenic ▪ barium ▪ beryllium ▪ bismuth ▪ boron ▪ cadmium ▪ calcium ▪ chromium ▪ cobalt	▪ copper ▪ iron ▪ lead ▪ lithium ▪ magnesium ▪ manganese ▪ mercury ▪ molybdenum ▪ nickel ▪ potassium ▪ selenium	▪ silicon ▪ silver ▪ sodium ▪ strontium ▪ thallium ▪ tin ▪ titanium ▪ uranium ▪ vanadium ▪ zinc

The sediment QA/QC program also includes five sediment replicate samples collected at each stream site to determine within site variability. Field split duplicate samples (i.e., the composite sample is divided into two separate sample bags) will be conducted for approximately 10% of the replicates and submitted to the analytical laboratory as blind duplicates to determine the effectiveness of sample homogenization. The RPD between sediment field splits will be calculated for every parameter with concentrations greater than five times the analytical MDLs, where A and B represent the concentration of the parameter in each split sample as follows (BC MWLAP 2013):

$$RPD = 100\% \times \left(\frac{|replicate\ 1 - replicate\ 2|}{\frac{replicate\ 1 + replicate\ 2}{2}} \right)$$

According to *British Columbia Field Sampling Manual Part A Quality Control and Quality Assurance* (BC MWLAP 2013), the data quality objective for field split samples is an RPD of less than 20%. An RPD greater than 20% indicates a possible problem, and an RPD greater than 50% indicates a definite problem such as contamination of lack of sample representativeness (BC MWLAP 2013).

Sediment quality observations will be examined in comparison to previous results. Based on professional judgement, outliers indicating an error will be removed.

Laboratory QA/QC includes evaluation of holding times, laboratory duplicates, certified reference material spikes, laboratory control samples, and method blanks.

4.5.1.3 Data Analysis

Evaluation of Project related effects (through Construction and Operations phases) for sediment particle size and sediment quality parameters will be completed by comparison to background (baseline) or reference condition ranges (graphical analysis) or a BACI analysis (Section 4.5.1.1).

For the purpose of data analysis and presentation, half of the analytical MDL will be calculated when parameter concentrations are less than the method MDL. Replicate samples will be averaged to obtain a site mean and standard error calculated.

Sediment chemistry parameters will also be compared to BC (ENV 2019, 2020a) and federal (CCME 2020a) SQG-AL as the first assessment endpoint (Table 4.5-1). For parameters with both a BC and CCME SQG-AL (arsenic, cadmium, chromium, copper, lead, mercury, and zinc), the guidelines are the same for both jurisdictions. British Columbia provides additional SQG-AL for iron, manganese, nickel, selenium, and silver.

British Columbia SQG-AL generally include a lower guideline and an upper guideline as these provide a flexible interpretive tool for evaluating the toxicological significance of sediment quality data. Sediment chemical concentrations below the lower guideline are rarely associated with adverse effects on biological communities and concentrations between the lower and upper guideline are occasionally associated with adverse biological effects. Sediment concentrations above the upper guideline are more frequently associated with adverse effects on biological communities. Similarly, the CCME guidelines include the Interim Sediment Quality Guidelines (ISQG) and the Probable Effect Levels (PEL), analogous to the BC lower and upper guidelines.

The percentage of stream sediment samples with concentrations greater than BC and CCME SQG-AL and the average factor by which concentrations are greater than the SQG-AL will be calculated.

As per the MDMER Schedule 5, sediment samples are to be collected and analyzed for particle size and TOC content to complement the benthic invertebrate community surveys. Cumulative data for particle size and sediment quality parameters will be presented graphically with SQG-AL where available. As the second assessment endpoint, particle size, TOC, and metal concentrations at each impact station sampled will be compared against available baseline information, as well as reference sites, to evaluate whether Project activities caused changes to sediment quality parameters outside of the background (baseline) range. Since baseline data collection is ongoing, reference ranges will be presented and summarized in the first AEMP report and will be based on the 5^{th} to 95^{th} percentile ranges for single parameters (e.g., TOC or metals).

For the third assessment endpoint, a BACI analysis will be performed to determine if changes in potential impact sites also occurred at reference sites. The interaction between the period (before or after) and class (impact or reference) effects reveals whether any before-after change in the mean parameter concentration that occurred in the impact site also occurred in the reference site. For the period effect, data will be grouped into one of two periods: before the start of construction (2011 to 2021) or after the start of construction (2022). To reduce the number of false positives (Type I error) due to the large number of statistical tests conducted, a reduced significance level (0.01) will be used when reviewing the results.

It is hypothesized that if mine activities affected sediment quality, then there would be a significant change in sediment quality at near-field impact sites in comparison with background (baseline) concentrations or reference ranges. The key effect of interest in this BACI design is the interaction effect. If potential impact site parameters increase or decrease over time relative to reference sites (i.e., a significant interaction effect), this may suggest that the Project is having an effect on the surrounding sediments (i.e., a non-parallel effect). However, the change over time at potential impact sites could also be due to natural episodic events (e.g., higher than average streamflow) or slight differences in sampling locations (leading to differences in grain size composition). If a change in the mean is detected by the before-after comparison, but the BACI analysis indicates that a parallel change also occurred at the reference site, it is reasonable to assume that this change is likely a natural phenomenon or unrelated to the Project activities. A precautionary approach will be used to determine if an effect is attributable to Project activities in cases of unexplained significant interactions using professional judgement, additional sampling, and/or field data to confirm significantly elevated or lower concentrations.

As described for surface water quality (Section 4.4.2), highly censored parameters (i.e., more than 70% of data below MDL) are considered unreliable and will not be subjected to effects analysis.

4.5.2 Sediment Toxicity Testing

Sediment toxicity testing will only be completed if triggered through the trigger response framework to aid in the interpretation of changes in sediment quality or changes in benthic communities (taxonomy). Planning for a sediment toxicity study would be triggered at the medium action level for either sediment quality (Section 6.2.2) or changes in benthic invertebrate community (Section 6.2.4) and would be implemented at the high action level for either water or periphyton chlorophyll *a* concentrations.

4.5.2.1 Measurement and Assessment Endpoints

Sub-lethal sediment toxicity tests will be completed on a test species and using a test method that is best suited for the investigation (i.e., will depend on the type of trigger for sediment toxicity testing; Table 4.5-3). For example, if sediment toxicity testing has been triggered based on a benthic invertebrate trigger, the testing will use a surrogate laboratory species for the potentially affected species. Test conditions will be based on the change in sediment concentrations observed. Prior to implementing sediment toxicity testing, BW Gold will consult with regulators (e.g., ENV, EAO) and Indigenous nations for input on the sampling plan design.

Table 4.5-3: Measurement and Assessment Endpoints for Sediment Toxicity

Measurement Endpoint	Assessment Endpoint
Sediment toxicity testing	LC_x or EC_x[1]

[1] Test species and endpoints (survival, growth, and/or reproduction) will be determined based on the type of investigation required.

4.5.2.2 Sampling Locations and Methods

Field Methods

In the event the sediment toxicity testing is triggered, this will be identified in the AEMP report and sampling for sediment toxicity testing will occur concurrently with the next scheduled aquatic resources sampling event (i.e., will be co-collected with sediment quality, primary producer, and benthic invertebrate sampling). Sediment samples for toxicity testing will be collected from the site identified in the trigger response framework (see Section 6.2.3 and 6.2.5) and one reference site.

Sediment toxicity testing samples must always be co-collected, spatially and temporally, with surface water quality and sediment quality samples, because the chemistry data are critical to interpretation of the sediment toxicity test results. Depending on the study design, both sediment and surface water from the site may be used in the laboratory-based toxicity testing.

Sample volumes and replicate numbers will vary depending on the study design (e.g., type and duration of the sediment toxicity testing). Sampling methods are likely to be similar to that described for sediment quality sampling (Section 4.5.1.2), although the targeted depths of sediment may vary with the type of test selected. As with sediment quality sampling, samples will be stored in coolers on ice and/or refrigerated until shipped to a CALA-accredited laboratory for toxicity testing. Laboratory chain of custody forms will also be used for submission of sediment toxicity testing samples.

Toxicity testing

Sediment toxicity testing will be carried out based on a sampling plan, which will be developed in consultation with Indigenous nations and regulators. The toxicity testing plan will be designed to account for the type of effect that triggered the sampling, but may include the use of one or more of the following standardized test organisms and assays:

- Invertebrates using the *Biological Test Method: Test for Survival, Growth and Reproduction in Sediment and Water Using the Freshwater Amphipod* Hyalella azteca (ECCC 2017); and
- Invertebrates using the *Biological Test Method: Test for Survival and Growth in Sediment Using Larvae of Freshwater Midges (*Chironomus tentans *or* Chironomus riparius) (Environment Canada 1997).

Additional types of tests using other freshwater invertebrates such as oligochaetes (e.g., *Lumbricoides variegatus* or *Tubifex tubifex*) or mayflies (e.g., *Hexagenia* sp.) may also be available through commercial laboratories such as Nautilus Environmental in Burnaby, BC.

4.5.2.3 Data Analysis

The specific data analysis to be used for sediment toxicity testing would be described in the sampling plan developed in consultation with Indigenous nations and regulators.

In general, it is expected that at the end of each laboratory-based test, the endpoint (e.g., growth, reproduction, or survival) is evaluated statistically to determine the LC_x (mortality) or EC_x (e.g., reproduction, growth). Results of the sediment toxicity testing will be interpreted based on comparison between control (reference) and impact (downstream of the mine site) sites, as well as considering results of the co-collected water and sediment chemistry data and aquatic resources sampling results.

Results of sediment toxicity testing are intended to be a supplemental line of evidence to other data collected under the AEMP and will not be used alone to identify Project-related effects in the receiving environment.

4.6 Aquatic Primary Producers

4.6.1 Measurement Endpoints and Assessment Endpoints

Periphyton (attached algae, fungi, bacteria, and associated detritus, also referred to as biofilm; BC MOE 2016a) was measured during baseline studies (see Section 3.3). Periphyton was selected for the aquatic plant monitoring required by EAC Condition 30(g) instead of macrophytes as an indicator of water quality and primary productivity. Aquatic macrophytes (aquatic plants that are often rooted or with roots that have distinct component structures large enough to be visible to the naked eye; BC MOE 2016a) are generally more abundant in lentic environments and, as indicated during baseline monitoring completed in 2011 and 2012, there was minimal macrophyte coverage at AEMP sampling locations (Appendix 2-O, Fish and Aquatic Resources 2011-2012 Baseline Report).

The selected measurement endpoints for periphyton analysis are focused on metrics associated with the primary producer (plant) component of periphyton. Periphyton biomass (as chlorophyll a) will be assessed to determine Project-related effects on aquatic primary producers (Table 4.6-1). Assessment endpoints will include comparison to BC guideline for the protection of freshwater aquatic life, and BACI analysis.

Table 4.6-1: Measurement and Assessment Endpoints for Aquatic Primary Producers

Measurement Endpoint	Assessment Endpoint
Biomass (as chlorophyll *a*)	Comparison to guidelines Before-after-control-impact (BACI) analysis
Taxonomy (community composition)	Comparison to background or reference ranges[1]

[1] Diversity indices genus richness and the Simpson's Diversity Index will be assessed if triggered under the trigger response framework.

Periphyton community composition (taxonomy) will only be completed if triggered through the trigger response framework to aid in the understanding of changes in periphyton biomass. Planning for a periphyton community composition study would be triggered at the medium action level for either water quality (Section 6.2.1) or periphyton chlorophyll *a* concentrations (Section 6.2.3) and would be implemented at the high action level for either water or periphyton chlorophyll *a* concentrations. The assessment endpoint for community composition would be comparison to background (baseline) or reference ranges.

4.6.2 Sampling Locations and Methods

4.6.2.1 Field Methods

Primary producers (periphyton) biomass and community composition samples (if triggered) will be collected at stream sites (Table 4.2-2; Figure 4.2-1). Sampling frequency will initially be once per year, with sampling frequency decreased by one year for each three-year period where no significant effects are identified. The minimum sampling frequency is once every three years, occurring at the same time as other aquatic resource sampling in late August or early September (Table 4.2-2).

Sampling will follow established protocols *British Columbia Field Sampling Manual* (BC MWLAP 2013). Five replicate periphyton samples per site will be collected using a template of known area (19.6 cm^2) from a rock large enough to collect three complete template scrapings. The periphyton within the template will be scraped and rinsed from the rock and transferred into a pre-labelled sample jar, where one replicate is a composite of three template scrapings from the same rock. Samples will be stored with ice packs in coolers until they can be processed.

Periphyton biomass samples will be processed by gently filtering samples filtered through a 0.45 µm filter. Filters will be stored and transported frozen and in the dark to an analytical laboratory.

The periphyton community samples will be preserved with Lugol's Iodine solution, kept cool, and transported to a qualified taxonomist for identification and enumeration.

4.6.2.2 Laboratory Analysis

Analysis of periphyton biomass (as chlorophyll *a*) will be completed at a CALA-accredited laboratory. Periphyton samples will be quantified for chlorophyll *a* (i.e., concentration), which is a pigment associated with photosynthesis and an indicator of primary producer biomass.

For the taxonomy samples, at the laboratory the sample volume is measured using a graduated cylinder and the initial sample volume is recorded. Depending on the density of the algae and detritus observed, an appropriate subsample will be taken and the subsample volume is recorded. The subsample will be homogenized thoroughly and allowed to settle in an Utermohl-type settling chamber for approximately 24 hours to allow the algae to settle to the bottom. The settled sample is then examined and enumerated at 630× magnification using an inverted Leica microscope. For each sample taxa, cell counts are reported in cells/ml.

4.6.2.3 Quality Assurance/Quality Control

Five replicate periphyton biomass and taxonomy samples will be collected from each site to provide data on within site variability. The QA/QC principles for periphyton biomass sampling will follow those outlined in the *British Columbia Field Sampling Manual Part A Quality Control and Quality Assurance* (BC MWLAP 2013). Samples will be stored in appropriate containers and transported following accepted procedures. Chain-of-Custody forms will be used. The analysis of chlorophyll *a* concentration will be conducted by an accredited laboratory.

A qualified taxonomist will conduct the identification and enumeration of the periphyton samples and follow standard protocols for subsampling, reference collections, and data quality assurance.

The reproducibility of subsampling and taxonomy will be tested on 10% of periphyton samples. Two different taxonomists will subsample, identify, and enumerate periphyton from the same sample using identical methods. Results will be compared by calculating the percent similarity:

$$\text{Percent similarity} = 100 - 0.5 \sum |a - b|$$

where *a* is the percentage of individuals of a taxon in subsample A, and *b* is the percentage of the same taxon in subsample B. The percent similarity between the samples is an indication of subsampling and taxonomic precision. A percent similarity of greater than or equal to 70% is required as the acceptable QA/QC threshold. If 70% similarity is not met, the reasons for the discrepancies between analysts are discussed and necessary adjustments made to the dataset.

4.6.3 Data Analysis

Periphyton biomass (as chlorophyll *a*; µg chl *a*/cm^2) will be calculated for each replicate sample and a mean calculated for each stream site. Periphyton biomass at each of the stations sampled will be compared to the BC guideline for the protection of freshwater aquatic life (10 µg chl *a*/cm^2).

For each station sampled, BACI analysis will be used to determine Project-related effects on periphyton biomass (Table 4.6-1). Similar to both water (Section 4.4.2.3) and sediment quality (Section 4.5.1.3) analysis, a mixed model ANOVA will be used with a class effect as the potential impact sites or reference sites. A fixed effect of period (before versus after), and random effect of year to account for variability in chlorophyl *a* data will be included. The interaction between the period and class effects reveals whether any change in the mean biomass that occurred at the potential impact site was paralleled at the reference site. To reduce the number of false positives (Type I error) due to the large number of statistical tests that will be conducted, a reduced significance level (0.01) will be used when reviewing the results. It is hypothesized that if mine activities affected periphyton biomass in surface water, then there would be a significant change in periphyton biomass at near-field sites in comparison with background (baseline) concentrations or reference ranges.

If taxonomic analysis is completed, the periphyton mean total density and community composition of major taxonomic groups will be calculated and presented graphically for each sampling location. Mean diversity metrics (genus richness and Simpson's Diversity Index) will be compared against available baseline information as well as reference sites to evaluate whether Project activities caused changes to periphyton community indices.

Periphyton taxonomic data includes all organisms identified in the periphyton counts, except those that are not counted following a consistent method across years. Mean total density and community composition of a major taxonomic groups will be calculated and presented graphically for each site.

Diversity metrics will be calculated at the genus level. If periphyton are identified to the species level they will be grouped into their respective genera designation. If an organism is not identified to the genus level, and no other organism is identified within that group (i.e., order, family, etc.), it is assumed that there is one genus in that group of organisms. All other specimens are otherwise excluded from the diversity calculations. Diversity analyses include the calculation of genus richness and the Simpson's Diversity Index according to:

Genera richness, G = the total number of genera present per sample;

$$\textit{Simpson's Diversity Index, } D = 1 - \sum_{i=1}^{G} p_i^{\,2};$$

where G is the number of genera and p_i is the relative abundance of each genera calculated as n_i/N, where n_i is the number of individuals in genera i, and N is the total number of all individuals.

Richness is based on presence/absence of a taxa, with all taxa identified to genus included in richness calculations (i.e., taxa with unit-length measurements); however, taxa with different counting methods would be excluded from the Simpson's diversity calculations. Simpson's diversity can range from 0 (lowest diversity) to 1 (maximum diversity). The use of Simpson's diversity index accounts for both the number of taxa present and the relative abundance of organisms from each taxa (evenness).

4.7 Aquatic Invertebrates

4.7.1 Measurement and Assessment Endpoints

Benthic invertebrates are widely used as indicators of environmental conditions and changes in streams. Stream benthic invertebrate abundance, community composition, and diversity metrics assessed at each sampling location will be evaluated using RCA (Table 4.7-1). Using the available RCA models, provided by CABIN, the potentially impacted sites can be matched to the available reference sites with similar habitats for comparison of benthic invertebrate communities. The extent of the difference between the potentially impacted site and reference sites is the measure of the Project related effect. The Skeena 2010 model was used for the purpose of the baseline assessment however this reference model will be evaluated prior to completing the analysis using the methods provided in the CABIN protocols to determine if it continues to be appropriate (Environment Canada 2012b).

Table 4.7-1: Measurement and Assessment Endpoints for Aquatic Invertebrates

Measurement Endpoint	Assessment Endpoint
Abundance (number of organisms/unit area)	Reference Condition Approach (RCA) analysis
Taxonomy (community sampling)	Comparison to background or reference ranges[1] Reference Condition Approach (RCA) analysis[1]
Tissue metal concentration	Before-after-control-impact (BACI) analysis

[1] Simpson's Evenness, number of taxa, Bray-Curtis index

Benthic invertebrate tissue metal analysis will be completed only if triggered through the trigger response framework to aid in the understanding of changes in aquatic invertebrate abundance or community composition. Benthic invertebrate tissue metal analysis is not being proposed as a regular component of the AEMP because:

- There are no guidelines available based on benthic invertebrate tissues other than selenium. Selenium has not been identified as a POPC or POC for the Project and, therefore, it is not necessary for routine benthic invertebrate tissue monitoring.
- There are no reliable or established toxicity thresholds for tissue metals in benthic invertebrates therefore interpretation and usefulness of the benthic tissue metal analysis is limited.
- Routine monitoring of tissue concentrations in benthic invertebrates is unlikely to provide more information than obtained through the regular monitoring of surface water quality and sediment quality. Surface water quality and sediment quality are leading indicators for potential changes in benthic invertebrate tissue metal concentrations (i.e., the exposure pathway for uptake of metals into benthic invertebrates is through water and sediment). Therefore, if no changes are observed in surface water quality and sediment quality then corresponding changes to tissue concentrations in benthic invertebrates are unlikely.
- Collection of sufficient tissue volumes of benthic invertebrates for tissue metals analysis tends to be challenging, particularly at sites where abundance is relatively low, and can require a significant amount of disturbance to creek beds (which are also fish habitat). Therefore, the preference is to minimize the potential effects to fish and fish habitat due to the proposed monitoring program itself.

Planning for a benthic invertebrate tissue metal study would be triggered at the medium action level for either water quality (Section 6.2.1) or sediment quality (Section 6.2.2) and would be implemented at the high action level for either water or sediment quality. The assessment endpoint for tissue metals analysis would be changes identified at impact sites through BACI analysis. The assessment can provide an additional line of evidence to aid in interpretation of the water quality, sediment quality, and/or benthic invertebrate community observations. However as indicated above (i.e., no reliable or established toxicity thresholds for benthic invertebrate tissue metals), interpretation will be limited to the toxicity data available at the time of analysis.

4.7.2 Sampling Locations and Methods

4.7.2.1 Field Methods

Benthic invertebrate surveys will be conducted at locations identified in Table 4.2-2 and Figure 4.2-1. Sampling frequency will initially be once per year, with sampling frequency decreased by one year for each three-year period where no significant effects are identified. The minimum sampling frequency is once every three years, occurring at the same time as other aquatic resource sampling in late August or early September (Table 4.2-2). Sites were selected to coincide with water quality, sediment quality, and periphyton sampling.

Benthic invertebrate surveys will be conducted by CABIN-certified field personnel using a standard CABIN kick net (400-µm mesh) to collect one sample at each site. Each sample will be collected by placing the kick net downstream of the sampler with the flat bottom of the net resting on the substrate. The sampler will move upstream, zigzagging continuously, disturbing the substrate to a depth of 5 to 10 cm using a kicking motion while dragging the net along the bottom of the stream for a period of 3 minutes. Contents of the kick net sample will be transferred to a sieve and sample debris will be washed from the net. Large rocks will be scrubbed, rinsed, and removed from the sample. The contents will be transferred into a clean, pre-labelled sampling jar and preserved to a final concentration of 10% buffered formalin. Samples will be sent to an accredited taxonomic laboratory for sorting and identification following CABIN protocols (ECCC 2020).

A habitat characterization will also be assessed following CABIN protocols (Environment Canada 2012b) for each site. This includes characterizing the reach (canopy cover, streamside vegetation, periphyton coverage, etc.), channel (slope, wetted width, velocity, etc.), substrate (100-pebble count, embeddedness, etc.), and in-situ water chemistry (temperature, pH, conductivity, and dissolved oxygen).

If benthic invertebrate tissue metal samples are required, samples will be collected using a standard CABIN kick net (400-µm mesh) to collect five replicate samples at each site. Benthic invertebrates will be collected until a sufficient mass is sampled (approximately 0.5 g of tissue per replicate). Samples will be placed in a clean, pre-labelled sampling tube and frozen until analysis by a CALA-accredited laboratory.

4.7.2.2 Laboratory Analysis

Invertebrates will be sorted and identified to the lowest possible taxonomic level (usually genus). Ostracoda, Cladocera, Nematoda, Copepoda, Porifera, Platyhelminthes, and terrestrial organisms will be excluded from all analysis following Environment Canada CABIN protocols (ECCC 2020).

Tissue metal samples will be analyzed for percent moisture and total metals at the MDLs consistent with ENV requirements (BC MOE 2016a).

4.7.2.3 Quality Assurance/Quality Control

Qualified personnel will conduct the sampling and chain of custody forms will be used for all benthic invertebrate samples. Benthic invertebrate QA/QC will follow CABIN protocols (ECCC 2020), which include determining the sorting efficiency of the subsampled benthic invertebrates and the percent similarity of samples identified by two separate taxonomists. Percent similarity calculations were the same as those described in Section 4.6.2.3 for periphyton. For benthic invertebrates, a percent similarity of greater than or equal to 90% is the data quality objective. If this is not met, the reasons for the discrepancies between taxonomists are discussed. If a major discrepancy is found between the two taxonomists in terms of organism identification or enumeration, the last batch of samples that had been counted by the taxonomist under review is recounted.

If tissue metal samples collection is triggered, five replicates will be collected at each site to provide data on the within site variability. Field split duplicate samples will be collected at the rate of 10% of the total number of samples, where one sample (replicate) is split in half and the split sample is submitted as a blind sample for laboratory analysis. Laboratory QA/QC practices will be consistent with those required by ECCC (2020).

4.7.3 Data Analysis

Several community descriptors will be calculated from the taxonomic results, including benthic invertebrate abundance, family richness, Simpson's Diversity and Evenness indices, and the Bray-Curtis Index. Richness, diversity, and evenness calculation are performed on the whole community as well as EPT taxa.

Family richness is calculated as the total number of benthic invertebrate families present in each replicate sample. The Simpson's Diversity Index (D) is calculated as:

$$\text{Simpson Diversity Index (D)} = 1 - \sum_{i=1}^{F} p_i^2$$

where F is the number of families present (i.e., family richness), and p_i is the relative abundance of each family calculated as n_i/N, where n_i is the number of individuals in family i, and N is the total number of all individuals.

Simpson's Evenness Index (E) is calculated as:

$$\text{Simpson Evenness Index (E)} = 1/\sum_{i=1}^{F}(p_i^2)/F$$

Where E is the evenness, F is the number of families present (i.e., family richness), and p_i is the relative abundance of each family calculated as above.

A complete dissimilarity matrix is also generated that includes pairwise comparisons of all samples using the Bray-Curtis Index. The Bray-Curtis Index compares the community composition within a benthos sample to the median reference community composition in the CABIN database. This reference composition is generated from the median abundance of each represented family from all of the reference site replicates. Since the median reference composition is generated from the combined reference site replicates, the comparison of a single reference site replicate community to the median reference community composition will produce a dissimilarity value (although generally a much lower value than exposure sites). Because the Bray-Curtis Index measures the percent difference between sites, the greater the dissimilarity value between a site and the median reference community, the more dissimilar those benthos communities are. The Bray-Curtis Index ranges from 0 to 1, with 1 representing completely dissimilar communities, and 0 representing identical communities. This index is calculated as:

$$\text{Bray-Curtis Index (BC)} = \sum_{i=1}^{F} |\text{yi1} - \text{yi2}| \;/\; \sum_{i=1}^{F} |\text{yi1} + \text{yi2}|$$

where BC is the Bray-Curtis distance between sites 1 and 2, n is the total number of families present at the two sites, yi1 is the count for family i at site 1, and yi2 is the count for family i at site 2.

Standard summary statistics (minimum, maximum, median, mean, standard deviation, and standard error) are calculated for all benthic invertebrate endpoints described above for comparison to baseline and reference areas.

It is hypothesized that if mine activities affected benthic invertebrate communities, then there would be a significant divergence of benthos communities from the reference locations at near-field sites.

A BACI approach will be used to detect changes in benthic invertebrate tissue metal concentrations if triggered under the response framework. Analyses will be completed for tissue metals triggered to understand the potential effects on benthic invertebrates. The approach used for the BACI analysis for invertebrate tissue metal concentrations will be consistent with that described for other AEMP components

(Section 4.4.2.3, 4.5.1.3, and 4.6.3), where significant differences for the before-after period effect at impact versus reference sites will be tested using the class-period interaction term.

4.8 Fish Community

Description of the fish community will require four separate monitoring programs:

- Summer inventory of the fish community;
- Kokanee summer spawning survey;
- Kokanee spring escapement survey; and
- Rainbow trout spring spawning survey.

These monitoring programs will be completed at different times of the year and at separate locations. Sample requirements will follow BC MOE (2016a) and field protocols will follow BC MWLAP (2013).

4.8.1 Fish Community Inventory

The purpose of the fish community inventory survey is to describe both the structure of the fish community and fish health within the AEMP study area. The focus will be on rainbow trout in the waterways closest to the mine site because it is the most abundant and widespread species during the summer months, and because there is a resident population of immature rainbow trout. However, both kokanee and mountain whitefish will be sampled from Tatelkuz Lake and Kuyakuz Lake in support of CFMP monitoring.

Sampling will initially be conducted on an annual basis for at least the first eight years of operations, to ensure that two complete kokanee cohort generations are assessed. Beyond the eight-year mark, survey frequency for fish community may be reduced to once every two years, if no trend in fish community is observed.

4.8.1.1 Measurement and Assessment Endpoints

Measurement and assessment endpoints have been selected with a focus on non-lethal monitoring of the fish community to the extent possible. The summer fish inventory measurement endpoints will include an inventory of the fish community, fish health, and fish tissue chemistry (Table 4.8-1).

Table 4.8-1: Measurement and Assessment Endpoints for the Fish Community Survey

Measurement Endpoint	Assessment Endpoint
Fish inventory	Catch Per Unit Effort (CPUE) and fish density (fish/100 m^2) for each identified species, population structure
Fish health	Length, weight, age, condition
Fish tissue metal concentrations	Comparison to BC or CCME tissue residue guidelines for selenium or mercury (BC ENV 2019a; CCME 2021a) Comparison to background or reference ranges Before-after-control-impact (BACI) analysis

4.8.1.2 Sampling Locations and Methods

Field Methods

The fish community inventory will be completed at ten sites where surface water quality monitoring is completed (Table 4.2-2; Figure 4.2-1) to provide concurrent water and fish sampling at the same location (i.e., co-collected). Fish sampling will be completed as close as practical to the mapped surface water quality monitoring site, typically within 100 to 200 m (Table 4.2-2).

The fish community inventory survey will be completed in late summer (i.e., after late July or early August) to minimize potential impacts to developing rainbow trout embryos. Sites have been selected to avoid overlap with identified kokanee spawning areas and can therefore be sampled during kokanee spawning and egg incubation periods (i.e., late July to end of August, with kokanee egg incubation through until spring).

Fish will be collected using closed-site backpack electrofishing with block nets undertaken by a two-person crew using a backpack electrofisher. At each electrofishing site, blocking nets will be placed at the upstream and downstream ends of the area to be sampled. This area will be electrofished from the downstream blocking net to the upstream blocking net, and then back to the downstream blocking net. Sites will range from approximately 100 m to 200 m in length and the entire stream width will be sampled.

The voltage, duty cycle, and frequency settings will be adjusted based on site conditions to maximize efficiency and minimize the risk of injury to fish. The electrofishing effort will be recorded for each site.

Captured fish will be identified to species, enumerated, and measured for length (to the nearest 1 mm) and wet weight (to the nearest 0.1 g using a digital scale). Any lesions, parasites, or other anomalies on fish will be recorded before the fish are live released at the site of capture.

A subset of eight rainbow trout will be sampled at each site to obtain additional data on age and tissue metal content. For these detailed analyses, an aging structure will be collected and the whole body will be used to tissue metal analysis. Rainbow trout has been proposed for age and tissue sampling because there is potentially a resident population within the watersheds and because the life history characteristics of non-migratory rainbow trout make this species a good indicator for tracking metal contaminants (Environment Canada 2012a).

Rainbow trout, kokanee, and mountain whitefish will also be collected from Tatelkuz and Kuyakuz lakes for tissue metal and age analyses. Eight adult fish of each species will be captured from each lake using a combination of gill netting and angling. Fish intended for tissue chemistry analysis will be sacrificed, frozen immediately, and shipped to a laboratory for processing and analysis.

Laboratory Analysis

The whole carcass of sacrificed fish will be retained in the field for tissue metal analysis. All tissue samples will be immediately frozen in individually labelled plastic bags before being shipped to the laboratory for determination of tissue moisture and metal content. Small-bodied juvenile fish (i.e., those from streams) will have ageing structures removed by laboratory technicians, and the remaining whole-body sample will be submitted for metals analysis. Large-bodied adult fish (i.e., those from lakes) will have ageing structures removed by laboratory technicians, then liver, muscle, and carcass/viscera (carcass/viscera includes all fish tissue except otoliths, liver, and muscle) samples will be prepared for metals analysis. Otoliths will be analysed by a laboratory for age determination, and the remaining fish tissue samples will be submitted to a laboratory for analysis of metals and moisture content. Muscle tissue samples will also be analyzed for arsenic speciation.

Tissue samples will be analyzed for moisture content and metals (standard suite of parameters, including selenium and mercury) by a CALA-accredited analytical laboratory targeting detection limits described in BC MOE (2016a). Laboratory methods will be performed following BC ENV (2020) sample preparation procedures.

Otoliths, fin clips, and/or scales of sacrificed fish will be collected for estimation of fish age. These ageing structures will be removed and prepared (e.g., mounted, polished, or otherwise treated) as necessary. Age will determined by counting the number of annuli through a compound microscope.

Quality Assurance/Quality Control

Field equipment will be calibrated prior to the start of the field season, properly maintained, and kept clean and free of excess water. The fine scale balance will be located indoors on a flat surface; only a field scale will be taken to each site. All scales will be regularly tared to maintain accuracy while in use. Care will be taken to clean equipment between samples to prevent cross-contamination.

All captured fish will be identified to species and a subset will be photographed for verification of species identification. Sample bags, envelopes, and vials will be labelled with site name, date, and sample type. Inventory of all samples will be maintained and verified prior to shipping. Chain of custody forms will be completed and shipped with all samples.

All field data will be recorded on waterproof paper and examined for completeness and accuracy. Field notes will be photocopied immediately after field programs are completed. Photocopies of all field notes will be uploaded to a secure online database. Data will be entered into excel spreadsheets for future analysis.

For metal analysis, replicate data will be obtained for one fish per site for calculation of the RPD (see Section 4.4.2.2).

An RPD of less than 20% will be considered an acceptable difference, whereas an RPD greater than 20% will be considered as potentially the result of sampling or analytical error. An RPD analysis will only be completed for those tissue metal concentrations where both values are greater than five times the MDL (BC MWLAP 2013).

4.8.1.3 Data Analysis

Fish data will be transcribed from field notes and submitted to the ENV Fisheries Data Submission site.

All statistical analyses will be performed using R 2.13.2 (R Development Core Team 2011). The significance level (α) = 0.10 will be used for all statistical tests.

Catch-Per-Unit-Effort (CPUE)

Fish community data will be summarized by calculating catch-per-unit-effort (CPUE) for each individual fishing effort and fish species captured. The CPUE will be calculated as the number of fish captured per sampling device per unit time as follows;

Electrofishing:

*CPUE=number of fish caught * [100/(electrofishing effort, hr)]*

The CPUE is an index of relative abundance that can be used to compare fish populations over time with the assumption that catch is proportional to the amount of effort for each gear-type used. For effects assessment, a Mann-Kendall temporal trends test will be undertaken for each site and compared between control and impact sites: this will require a minimum of five years of sequential monitoring data. It is hypothesized that if mine activities affected the fish community, then there would be a significant reduction in CPUE at impact sites in comparison with no significant reduction at control sites.

Population Structure

Population structures of fish will be assessed using length frequency distributions and length-age regressions. The length frequency distributions between control and impact sites will be compared using a two-level Kolmogorov-Smirnov Test to test whether the distribution was the same across the two groups being compared. Five individual length measurements will be considered the minimum required for the Kolmogorov-Smirnov Test, although field sampling (Section 4.8.1.2) will aim to capture as many fish as possible to a maximum of 100 fish, to maximize the statistical power of the test.

It is hypothesized that if mine activities affected the fish community, then there would be a significant reduction in length and length-at-age at impact sites in comparison with no significant reduction at reference sites.

Fish Condition

Length-weight data will be plotted to visually assess the entire data set and to identify outliers. Once outliers are visually identified, potential explanations for the outlier values will be investigated and decisions will be made to either repair the outlier, include the outlier in data analysis, or remove the outlier from further analysis.

The length/weight data from reference sites and from historical data (Appendix 2-O, Fish and Aquatic Resources 2011 – 2012 Baseline Report; Appendix 2-P, Fish and Aquatic Resources 2013 Baseline Report) will be combined and a normal reference range will be calculated using specific length increments and the associated average weight data. The following equation will be used for definition of normal range:

$$log_{10}(W) = b * log_{10}(L) + a$$

where W = weight (g), L = length (mm), a = the intercept of the regression defined from the reference and historical data, and b = the slope of the regression defined from the reference and historical data.

The regression equation for the normal range will then used to calculate the $\log_{10}$ of expected weight as:

$$log_{10}(W_E) = b * log_{10}(L) + a$$

where W_E = expected weight (g), L = measured fork length (mm), a = the defined intercept of the regression and b = the defined slope of the regression. Residual $\log_{10}$(weight) values will then be calculated as the difference between expected and measured weight as:

$$W_R = W - W_E$$

where W_R = residual weight, W = measured weight, and W_E = expected weight. The median, 25th percentile, 75th percentile, and the interquartile range (IQR) for both negative and positive residuals will then be calculated. The upper and lower limits of the normal range of the residuals will then be calculated as:

$$NR_{UL} = 75\%ile + 1.5 \times IQR$$

$$NR_{LL} = 25\%ile - 1.5 \times IQR$$

where NR_{UL} = the upper limit of the normal range of the residuals, NR_{LL} = the lower limit of the normal range of the residuals, IQR = the interquartile range, 25%ile = 25th percentile value for the negative residuals, and 75%ile = 75th percentile value for the positive residuals.

The upper and lower limits of normal range for the length/weight linear regression will be calculated as:

$$log_{10}(W_{UL}) = (a - NR_{UL}) + b \times log_{10}(L\quad)$$

$$log_{10}(W_{LL}) = (a + NR_{LL}) + b \times log_{10}(L\quad)$$

where W_{UL} = normal range upper limit for weight (g), W_{LL} = normal range lower limit weight (g), L = fork length (mm), a = the intercept of the regression and b = the slope of the regression. The lower limit and upper limit of normal range will be used to assess the length/weight fit of fish from impact locations relative to the normal range, both among years and among sites. It is hypothesized that if mine activities affected the fish community, then there would be a loss of fish condition at impact sites in comparison with the normal range.

The relative condition (K_n) will be used as the metric for condition and will be calculated by comparing the measured weight to the expected weight from the measured length as:

$$K_n = \frac{W}{W_E}$$

where W = measured fish weight (g) and W_E = expected fish weight (g).

Relative condition will be statistically compared between reference and impact sites. First, the distributions will be tested for normality using an Anderson-Darling test and if normally distributed, a single factor ANOVA followed by a Tukey's multiple comparison test will be computed to compare relative condition. If the data are not normally distributed, a Kruskal-Wallis test by ranks will be used with a Steel-Dwass test for multiple comparisons. Significance will be assumed when $p < 0.10$. It is hypothesized that if mine activities affected the fish community, then there would be a significant loss of fish condition at impact sites in comparison with no significant loss of fish condition at reference sites.

Tissue Metal Content

For tissue metals analysis, summary statistics (mean and standard deviation) for dry weight and wet weight metal contents will be calculated. If a measurement is below the MDL, then half the MDL will be used during calculations of summary statistics. The analysis will focus on selenium and mercury because there are tissue residue guidelines (BC ENV 2019a). Additional parameters may be included in AEMP reporting if changes in water quality are identified (Section 4.4.2.3), particularly if those changes were not predicted by the surface water quality model.

Selenium and mercury concentrations in fish tissue will be compared to BC (ENV 2019a) and federal (CCME 2020a) tissue residue guidelines as the first assessment endpoint (Table 4.8-1). Concentrations will also be compared to background or reference ranges of selenium and mercury concentrations in fish tissue. The background and reference ranges of selenium and mercury concentrations will be defined and summarized in the first AEMP report (including tissue samples collected in summer 2021).

To further assess Project-related effects on tissue metal concentrations a BACI analysis will be completed (Table 4.8-1) to determine if changes in tissue metal concentrations at potential impact sites also occurred at reference sites. The interaction between the period (before or after) and class (impact or reference) effects reveals whether any before-after change in the mean parameter concentration that occurred in the impact site also occurred in the reference site. For the period effect, data will be grouped into one of two periods: before the start of construction (2011 to 2021) or after the start of construction (2022). To reduce the number of false positives (Type I error) due to the large number of statistical tests conducted, a reduced significance level (0.01) will be used when reviewing the results.

It is hypothesized that if mine activities affected concentrations of metals in surface water and the metals were taken up from the water into fish tissue, then there would be a significant increase in metal content of fish collected at impact sites (particularly at near-field sites) in comparison with background (baseline) concentrations or reference ranges.

The key effect of interest in this BACI design is the interaction effect. If potential impact site fish tissue metal concentrations increase or decrease over time relative to reference sites (i.e., a significant interaction effect), this may suggest that the Project is having an effect on fish tissue metal concentrations (i.e., a non-parallel effect). However, if a change in the mean is detected by the before-after comparison, but the BACI analysis indicates that a parallel change also occurred at the reference site, it is reasonable to assume that this change is likely a natural phenomenon and unrelated to the Project activities. Similarly, if a change is detected at mid- or far-field sites but not at near-field sites, it is reasonable to conclude that this change is likely the result of non-Project activities (e.g., forestry or agricultural activities). Thus, professional judgment is used to determine if a statistically significant interaction effect is likely attributable to Project activities.

As described for surface water quality (Section 4.4.2) and sediment quality (Section 4.5.1.3), highly censored parameters (i.e., more than 70% of data below MDL) are considered unreliable and will not be subjected to effects analysis.

4.8.2 Kokanee Summer Spawning Survey

The purpose of the kokanee summer spawning survey is to monitor the size of the kokanee spawning run in the AEMP study area. Kokanee spawning success will be assessed for effects related to changes in water quality and the water withdrawal from Tatelkuz Lake to Davidson Creek.

4.8.2.1 Measurement Endpoints, Assessment Endpoints

The assessment endpoints for the kokanee summer spawning survey will be the number of spawning kokanee and the number of kokanee redds recorded during the survey (Table 4.8-2).

Table 4.8-2: Measurement and Assessment Endpoints for the Kokanee Spawning Survey

Measurement Endpoint	Assessment Endpoint
Kokanee spawning	Number of spawning kokanee Number of redds

4.8.2.2 Sampling Locations and Methods

Field Methods

Monitoring of spawning kokanee will be completed at five sampling locations (Table 4.2-2; Figure 4.2-1). The selected reaches within each of the sampling location (Table 4.8-3) will provide data on the movement of spawning kokanee from Tatelkuz Lake and Kuyakuz Lake into specific watersheds, including the Davidson Creek watershed, the Creek 661 watershed, and the Chedakuz Creek watershed downstream and upstream of Lake Tatelkuz and upstream of Kuyakuz Lake.

Table 4.8-3: Potential Kokanee Summer Spawning Survey Monitoring Reaches

Stream	Reach	Site ID #	UTM Coordinates	
			Easting	Northing
Davidson Creek	1	DC-20	384600	5908028
Creek 661	1	661-20	388707	5899424
Lower Chedakuz Creek	15	CC-15	384433	5909321
Middle Chedakuz Creek	20	CC-05	388719	5899416
Upper Chedakuz Creek	27	CC-01	398132	5889857

The kokanee spawning survey will be completed initially on an annual basis to capture all separate ‘runs’ because it is hypothesized that there are four separate ‘run-years’ of kokanee. The spawning survey will occur from mid July to late September (Table 4.2-3), which is when the kokanee have been observed to spawn (Appendix 2-O, Fish and Aquatic Resources 2011-12 Baseline Report; and Appendix 2-P, Fish and Aquatic Resources 2013 Baseline Report). The lengthy monitoring period is due to the differential spawning periods in the various watersheds (e.g., lower Chedakuz Creek is weeks later than other reaches). It is expected, however, that the spawning run will occur over a period of approximately four weeks at any given site.

Kokanee and kokanee redds will be counted weekly over a four-week period by a two-person crew hiking upstream along each selected 500 m reach of stream (Table 4.8-3). By walking upstream, the crew will reduce the startle response of fish, which are usually oriented head-first into the flowing water. This will increase the probability of accurately counting fish.

Both live and dead kokanee will be counted, but as separate categories. Live fish will be further classified as migrating, holding, spawning, or spent, depending on their behaviour. Migrating fish will be those swimming steadily, usually upstream. Holding fish will be those paired and occupying a station. Spawning fish will be those paired and engaged in courtship behaviour with one or more mates, or actively digging or guarding a redd. Spent fish will be those observed in pools and backwaters or drifting downstream along the stream margins with clear damage to body and fins.

Fish in each of the five classes will be counted individually by each crew member and then the two sets of counts will be compared at the end of a survey section. The set with the larger numbers will be selected as the best representative of the number of fish in that reach.

Information will be recorded for the start and end location of the survey as measured by GPS, water temperature (ºC), dissolved oxygen (mg/L), pH, conductivity (µS/cm), creek width (m), redd habitat type (glide, riffle, or pool) based on fish habitat assessment procedures (Johnston and Slaney 1996), and dominant and subdominant substrate in redds based on RISC standards (BC FISB 2001).

Concurrent with the visual survey, a drone-based survey will also be completed. This will provide a permanent record of spawning activity. Drone-based and visual surveys will occur once each week over the four-week peak spawning period for comparison of the two survey methods with the goal of relying primarily on drone-based surveys in subsequent years.

All data will be recorded in field notebooks and photographs will be taken of selected stream sites.

Quality Assurance/Quality Control

Field equipment will be calibrated prior to the start of the field season, properly maintained, and kept clean and free of excess water.

All field data will be recorded on waterproof paper and examined for completeness and accuracy. Field notes will be photocopied immediately after field programs are completed. Photocopies of all field notes will be uploaded to a secure online database. Data will be entered into excel spreadsheets for future analysis.

4.8.2.3 Data Analysis

To standardize counts of kokanee spawners and kokanee redds, counts will divided by both the length of stream and by the estimated area of stream that was surveyed.

The kokanee salmon life cycle (fertilization to spawning and death) can span from three to five years, with the majority of fish returning to spawn and then die in their fourth year. Similar to Sockeye Salmon and other Pacific salmon species, fish returning each year are the progeny of fish that spawned four years earlier and mostly separated from other years. Because of this cyclical trend, each “run-year” should be treated as a separate entity in assessing abundance trends, rather than a general assessment of abundance across all years.

Currently, there are baseline data for kokanee spawning for three of the four possible ‘run-years’. These data are based on the kokanee spawning surveys that occurred in 2011, 2012, and 2013 (Appendix 2-O, 2011 – 2012 Fish and Aquatic Resources Baseline Report; and Appendix 2-P, 2013 Fish and Aquatic Resources Baseline Report). The kokanee that spawn in 2022 will be progeny of the 2010/2014/2018 run-year: with a 2022 spawning survey there will be baseline information available for all four run-years of kokanee.

A Mann-Kendall temporal trends analysis will be used to assess for temporal alterations in spawning activity for each run-year. It is hypothesized that if mine activities affected the kokanee community, then there would be a significant decrease in spawning activity at impact sites in comparison with spawning at control sites or there would be a significant decline in spawning activity over time.

4.8.3 Kokanee Fry Spring Escapement Survey

The purpose of the kokanee escapement survey is to monitor the success of the kokanee spawning run in the AEMP study area. The results of the surveys will be assessed for effects related to changes in water quality and of water withdrawal from Tatelkuz Lake and into Davidson Creek.

4.8.3.1 Measurement Endpoints and Assessment Endpoints

The assessment endpoints for the kokanee summer spawning survey will be the number of spawning kokanee recorded during the survey and the length weight distribution, and condition of fry (Table 4.8-4).

Table 4.8-4: Measurement and Assessment Endpoints for the Kokanee Escapement Survey

Measurement Endpoint	Assessment Endpoint
Fish inventory	Number of spawning kokanee, population structure
Fish health	Length, weight, condition

4.8.3.2 Sampling Locations and Methods

Field Methods

Five sites will be monitored for kokanee escapement (Table 4.2-2; Figure 4.2-1). The selected reach to be sampled at these sampling locations (Table 4.8-5) will provide data on the movement of kokanee fry from specific watersheds, including the Davidson Creek watershed, the Creek 661 watershed, and the Chedakuz Creek watershed into Tatelkuz Lake or Kuyakuz Lake.

Table 4.8-5: Potential Kokanee Escapement Survey Monitoring Locations

Stream	Reach	Site ID #	UTM Coordinates	
			Easting	Northing
Davidson Creek	1	DC-20	384600	5908028
Creek 661	1	661-20	388707	5899424
Lower Chedakuz Creek	15	CC-15	384433	5909321
Middle Chedakuz Creek	20	CC-05	388719	5899416
Upper Chedakuz Creek	27	CC-01	398132	5889857

The escapement survey will be completed initially on an annual basis in early spring (freshet; Table 4.2-3). The initial annual surveys are expected to capture all separate ‘run years’ because it is hypothesized that there are four separate ‘run years’ of kokanee. The escapement survey will occur during spring freshet, which is when the kokanee fry are expected to return to the lake (Appendix 2-O, Fish and Aquatic Resources 2011-12 Baseline Report; and Appendix 2-P, Fish and Aquatic Resources 2013 Baseline Report).

The kokanee fry escapement survey field program will be undertaken using an underwater camera and block nets to direct fish past the camera. The program will include detailed measurement of surface water temperature (°C), dissolved oxygen (mg/L), pH, and conductivity (µS/cm).

The kokanee fry will be collected using dip nets. Captured fish will be measured for length (to the nearest 1 mm) and wet weight (to the nearest 0.1 g, or to the nearest 0.01 g). Any lesions, parasites, or other anomalies on fish will be recorded before the fish are live released at the site of capture.

Quality Assurance/Quality Control

Field equipment will be calibrated prior to the start of the field season, properly maintained, and kept clean and free of excess water. The fine scale balance will be located indoors on a flat surface; only a field scale will be taken to each site. All scales will be regularly tared to maintain accuracy while in use. Care will be taken to clean equipment between samples to prevent cross-contamination.

All field data will be recorded on waterproof paper and examined for completeness and accuracy. Field notes will be photocopied immediately after field programs are completed. Photocopies of all field notes will be uploaded to a secure online database. Data will be entered into excel spreadsheets for future analysis.

4.8.3.3 Data Analysis

Data analysis will follow the approach used for the summer inventory monitoring program (Section 4.7.3).

4.8.4 Rainbow Trout Spring Spawning Survey

The purpose of the rainbow trout spring spawning survey is to monitor the size of the rainbow trout spawning run in the AEMP study area. The results of the surveys will be assessed for effects related to changes in water quality, from water withdrawal from Tatelkuz Lake to Davidson Creek, or the rerouting of water from Lake 1682 into Lake 1538 on rainbow trout spawning success.

4.8.4.1 Measurement Endpoints, Assessment Endpoints, and Data Analysis

Measurement and assessment endpoints will be specifically selected with a focus on non-lethal monitoring of the fish community. The spring spawning survey measurement endpoints will include an inventory of the number and age of the spawning rainbow trout community, and fish health assessed with length and weight data (Table 4.8-6).

Table 4.8-6: Measurement and Assessment Endpoints for the Rainbow Trout Spring Spawning Survey

Measurement Endpoint	Assessment Endpoint
Fish inventory	Number of spawning rainbow trout, population structure
Fish health	Length, weight, age, condition

4.8.4.2 Sampling Locations and Methods

Field Methods

Rainbow trout spawning will be monitored at four sampling locations (Table 4.2-2; Figure 4.2-1). Sample locations were selected are based on baseline studies (Appendix 2-O, 2011 – 2012 Fish and Aquatic Resources Baseline Report; and Appendix 2-P, 2013 Fish and Aquatic Resources Baseline Report). Surveys will be completed within a reach of each site (Table 4.8-7) and are designed to provide data on the movement of spawning rainbow trout from Tatelkuz Lake and Kuyakuz Lake into specific watersheds, including the Davidson Creek watershed, the Creek 661 watershed, and the Turtle Creek watershed downstream and upstream of Lake Tatelkuz and downstream of Kuyakuz Lake.

The rainbow trout spawning survey will be completed in late May to late June. Specific timing of the surveys will be dependent on creek temperature (Table 4.2-3).

Table 4.8-7: Potential Rainbow Trout Monitoring Locations

Stream	Reach	Exposure	Site ID	UTM Coordinates	
				Easting	Northing
Davidson Creek	1	Impact	DC-20	384399	5907792
Creek 661	1	Impact	661-20	388683	5899443
Turtle Creek	1	Control	TC-15	383309	5908697

The spring rainbow trout spawner survey field program will comprise the following tasks:

- Installation of paired upstream- and downstream-facing hoop nets at each site;
- Daily hoop net checks for spawning rainbow trout which will include:
  - Marking rainbow trout with t-bar (floy) tags to track fish movement;
  - Enumeration of rainbow trout;
  - Measurement of length (mm) and weight (g) on a selection of fish; and
  - Collection of aging structures on a selection of fish;
- If site and water level conditions permit, supplemental camera placement might be possible; and
- In situ daily surface water monitoring at hoop net sites for temperature (°C), dissolved oxygen (mg/L), pH, and conductivity (µS/cm).

Data Analysis

Fish data will be transcribed from field notes and submitted to the ENV Fisheries Data Submission site.

All statistical analyses will be performed using R 2.13.2 (R Development Core Team 2011). The significance level (α) = 0.10 will be used for all statistical tests.

Abundance

A Mann-Kendall temporal trends analysis will be used to assess for temporal alterations in spawning activity. It is hypothesized that if mine activities affected the rainbow trout community, then there would be a significant decrease in spawning activity at impact sites in comparison with spawning at control sites, or there would be a significant decline in spawning activity over time.

Population Structure

Population structures of fish will be assessed using length frequency distributions and length-age regressions. The length frequency distributions between control and impact sites will be compared using a two-level Kolmogorov-Smirnov Test to test whether the distribution was the same across the two groups being compared. A minimum of five individual length measurements will be considered the minimum required for the Kolmogorov-Smirnov Test.

It is hypothesized that if mine activities affected the fish community, then there would be a significant reduction in length and length-at-age at impact sites in comparison with no significant reduction at control sites.

Fish Condition

Fish condition will be assessed using the same methods and analyses as discussed in Section 4.8.1.3.

4.9 Water-dependent Wildlife

Assessment of amphibians or waterbirds will only be completed if triggered through the trigger response framework to aid in the understanding the effects of WQG-AL exceedances and/or significant Project related changes in water quality. Planning for a water-dependent wildlife study would be triggered at the medium action level for water quality (Section 6.2.1) and would be implemented at the high action level for either water quality.

4.9.1 Measurement and Assessment Endpoints

Graphical analysis of the spatial distribution of target species will be completed to compare baseline and Construction or Operation phase years (Table 4.9-1). Dependent on the availability of data, statistical analysis may be developed to evaluate if Project related changes have occurred.

Table 4.9-1: Measurement and Assessment Endpoints for Water-dependent Wildlife

Measurement Endpoint	Assessment Endpoint
Presence or non-detection	Graphical analysis of spatial distribution

4.9.2 Sampling Locations and Methods

Amphibian and/or waterbird surveys will be completed at selected sites (breeding ponds), dependent where the monitoring is triggered (see also Appendix 9-H, Wildlife Mitigation and Monitoring Plan). Sites with available baseline data will preferentially be selected (see Appendix 2-R, Wildlife and Wildlife Habitat Baseline Report and Appendix 2-S, Consolidated Wildlife Effects Assessment); however, sampling design will be developed dependent on the identified water quality effects.

Amphibian sampling will be completed using the same protocols used during baseline assessments (see Appendix 2-R, Wildlife and Wildlife Habitat Baseline Report; and Appendix 2-S, Consolidated Wildlife Effects Assessment). Surveys will be completed to determine presence or non-detection of species following the *Inventory Methods for Pond Breeding Amphibians and Painted Turtle* (RIC 1998). Visual encounter and road-based surveys will be completed during the breeding season to determine the presence of breeding amphibians.

Aerial breeding waterbird surveys will be conducted using the aerial transect survey methodology (RIC 1999). All waterbirds encountered during the surveys will be identified by species and age, sex, and number of individuals will be recorded if possible.

5. TRIGGER ACTION RESPONSE PLAN

A trigger action response plan applies to the immediate term trigger levels and immediate actions to be completed in response to reaching a trigger level. The actions to be completed will reflect the level of risk associated when the trigger level has been reached with the main objective to meet permit conditions, DS conditions 3.8 and 3.9 and/or prevent irreversible adverse effects. Fish habitat endpoints have been included in the trigger action response plan and are based on indicators used for hydrology (Section 4.3), and water temperature (Section 4.4.1).

Monitoring of trigger level exceedances and actions will be completed on a frequency defined for the fish habitat endpoint. Reporting of the exceedances and associated mitigations will be completed on an annual basis in the AEMP report.

Water quality endpoints have not been included in the trigger action response plan because as part of the MSDP (Appendix 9-E) effluent water will meet BC WQG-AL or approved SBEBs prior to discharge from the FWR. Water treatment is the primary mitigation strategy to meet the discharge water quality limits and therefore protect water quality in Davidson Creek.

Station DC-05 in upper Davidson Creek is considered the point of compliance at which water flows are expected to meet IFN. The FWR will also have a flowmeter installed to assess if surface water flows from the FWR are sufficient to maintain the IFN (MSDP, Appendix 9-E). Thus, trigger levels for fish habitat (as hydrology in Davidson Creek) have been defined in relation to the IFN (Table 5-1). Detailed description of the IFN is available in *Blackwater Fisheries Offsetting Plan – Instream Flow Needs for Davidson Creek* (Palmer 2021).

Table 5-1: Triggers and Action Responses for Fish Habitat – Hydrology

Level	Trigger	Action Response
None	Weekly mean flow is greater than 50% above the IFN.	No change to mitigation as mitigation measures are performing as expected.
Low	Weekly mean flow is 50% above the IFN.	Responses will include: ▪ Check accuracy of hydrological data, compare hydrology station results to confirm proper functioning, and confirm that the FWSS is operating as designed. Additional responses may include: ▪ Discussion with water control structure (e.g., FWSS, FWR) operations team to identify requirements for potentially increased flow from FWSS.
Medium	Weekly mean flow is 25% above the IFN.	Responses will include: ▪ Increase hydrological monitoring efforts to better characterize current conditions and notify regulators of the developing situation. Additional responses may include: ▪ Prepare to implement protocols and procedures for increased flow from the water control structure (FWSS, FWR) through discussion with the operations team and regulators.
High	Weekly mean flow is 10% above the IFN.	Responses will include: ▪ Assess the need to increase flow from the water control structures (e.g., FWSS, FWR) as required to prepare to meet IFN requirements.

Surface water temperature, downstream of the Project, in Davidson Creek is also expected to change as a result of flow augmentation from the FWR. Thus trigger levels for fish habitat (as surface water temperature) have been defined in relation to BC provincial WQG for temperature for rainbow trout and kokanee[3] and literature review of thermal tolerance limits (BC MOE 2001a; Lee and Rinne 1980) (Table 5-2). Project-specific life history timing for these species is based on baseline data collected in support of the EA Application (see Table 5.10-3 in 2011-2012 Baseline Report – Fish and Aquatic Resources).

The surface water trigger levels would also apply to the outlet of the FWR (see Appendix 9-E, MSDP) where monitoring is completed on a weekly frequency in addition to station DC-05 (point of compliance) in Davidson Creek.

Table 5-2: Triggers and Action Responses for Fish Habitat – Temperature

Level	Trigger[1]	Action Response
None	■ Weekly mean stream temperatures are within the optimum temperature range for rainbow trout and kokanee for the relevant timing and life history stages.	No change to mitigation as mitigation measures are performing as expected.
Low	■ Weekly mean stream temperatures in Davidson Creek are within 2 ºC of the minimum or maximum optimum temperature range for rainbow trout and kokanee for the relevant timing and life history stage.	Responses will include: ■ Check accuracy of monitoring equipment and determine whether the water control structure (FWR) is operating as designed. Additional responses may include: ■ Assess air temperature data to determine whether surface temperatures are beyond normal range.
Medium	■ Weekly mean stream temperatures in Davidson Creek are greater than 2 ºC outside of the optimum temperature ranges for rainbow trout and kokanee for the relevant timing and life history stage.	Responses will include: ■ Increase temperature monitoring in Davidson Creek and in the water control structure (FWSS, FWR) and notify regulators of current conditions. Additional responses may include: ■ Prepare to implement protocols and procedures for adjusting flow from the water control structure (FWSS, FWR) as required to mitigate changes to temperature.
High	■ Weekly mean stream temperatures in Davidson Creek are at incipient lethal temperatures for kokanee or rainbow trout for the relevant timing and life history stage.	Responses will include: ■ Immediately adjust flows into and out of the water control structure (FWSS, FWR) to ameliorate temperature increases. Additional responses may include: ■ Conduct fish and fish habitat surveys to assess potential lethality of the stream temperatures.

Notes:

Rainbow Trout Optimum Temperature Ranges (BC MOE 2001a), Incipient Lethal Temperatures (ILT; BC MOE 2001a, Lee and Rinne 1980), and Life History Stage Timing for Davidson Creek are:

- *Embryo Incubation - Range: 10.0 °C – 12.0 °C; ILT: 18.0 °C; Timing: 1 June to 31 July.*
- *Juvenile Rearing - Range: 16.0 °C – 18.0 °C; ILT: 24.0 °C; Timing: 1 July to 15 November.*
- *Adult Migration - no temperature range provided in WQG.*
- *Adult Spawning - Range: 10.0 °C – 15.5 °C; ILT: 27.0 °C; Timing: 15 May to 30 June.*

Kokanee (Sockeye Salmon) Optimum Temperature Ranges (BC MOE 2001a), ILT (BC MOE 2001a), and Life History Stage Timing for Davidson Creek are:

- *Embryo Incubation - Range: 4.0 °C – 13.0 °C; ILT: 15.5 °C; Timing: 1 September to 30 April (of the following year).*
- *Juvenile Rearing - not applicable to Davidson Creek - juveniles outmigrate soon after emergence and rear elsewhere.*
- *Adult Migration - Range: 7.2 °C – 15.6 °C; ILT: 22.2 °C; Timing: 1 August to 30 September.*

[3] The BC WQG provide optimum temperature ranges for Sockeye Salmon (*Oncorhynchus nerka*), but not for kokanee, a freshwater-resident life history variant of the same species. The Sockeye Salmon temperature range will be applied to kokanee for the purposes of assessing temperature suitability.

6. ADAPTIVE MANAGEMENT

6.1 Adaptive Management Framework

The AEMP plan is a living document that will evolve over time in response to the results of the monitoring program, changing conditions or development at the site, updates to scientific methods, and through consultation and discussions with Indigenous nations, regulators, or other stakeholders. This process of improvement with changing conditions is referred to as adaptive management.

Condition 3 of EAC requires an adaptive management to provide a framework for identifying triggers to determine effectiveness of mitigation and whether additional mitigation is required to address effects of the Project on water and sediment quality, aquatic resources, and fish. The monitoring (AEMP) and adaptive management plan, as defined in Condition 3(d) to 3(l) of the EAC, must include:

"3(d) the monitoring program that will be used including methods, location, frequency, timing and duration of the monitoring;

3(e) the baseline information that will be used, or collected where existing baseline information is insufficient, to support the monitoring program;

3(f) the scope, content and frequency of reporting of the monitoring results;

3(g) the identification of qualitative and quantitative triggers, which, when observed through monitoring required under paragraph d), will require the Holder to alter existing, or develop new, mitigation measures to avoid, reduce, and/or remediate effects;

3(h) methods that will be applied to detect when a numeric trigger, or type or level of change referred to in paragraph g) occurs;

3(i) a description of the process for and timing to alter existing mitigation measures or develop new mitigation measures to reduce or avoid effects;

3(j) identification of the new and/or altered mitigation measures that will be applied when any of the changes identified in paragraphs a) to c) occur, or the process by which those will be established and updated over the relevant timeframe for the specific condition;

3(k) the monitoring program that will be used to determine if the altered or new mitigation measures and/or remediation activities are effectively mitigating or remediating the effects and or avoiding potential effects; and

3(l) The scope, content and frequency of reporting on the implementation of altered or new mitigation measures."

Figure 6.1-1 identifies the components of the adaptive management framework.

Figure 6.1-1: Adaptive Management Framework

Plan: The AEMP study design considered planned mitigation measures and the requirements for aquatic effects monitoring programs to meet EAC Condition 41. BW Gold is engaging with Indigenous groups and relevant federal and provincial authorities on these measures and programs.

Do: Implementing the mitigation measures as described in Section 5.6 (Modelling, Mitigations, and Discharge) and in the Mitigation and Management Plans sections for each receptor component in Chapter 6 (Environmental Effect Predictions).

Monitor: Section 4 of the AEMP plan includes monitoring programs to determine if, after mitigations and management has been applied, Project-related effects to the aquatic receiving environment occur.

BW Gold will review and update monitoring programs, including the AEMP, as required during the life of the Project. This will include:

- Review of the monitoring program in terms of effectiveness in detecting effects;
- Recommendations provided by a QP for changes to the monitoring plan, objectives, frequency, methods, or timing; and
- Engagement tracking to record input from Indigenous groups and regulators such as the EAO and ENV.

Adjust: Quantitative triggers to measure the level of change relative to baseline conditions, predicted conditions, and other benchmarks such as water and sediment quality guidelines were developed to determine whether existing (proposed) mitigation measures need to be altered or additional mitigation measures implemented.

Triggers were provided at the following levels of the adaptive management framework: none, low, medium, and high. The framework is intended to provide an early-warning system such that when defined action levels (none, low, medium, and high) are triggered there is sufficient time to prevent irreversible adverse effects. Reporting on the trigger response framework will be completed on an annual basis as part of the AEMP report and will include the appropriate management responses to be completed.

6.2 Aquatic Effects Trigger Response Framework

For each of the AEMP monitoring components the following is required for an effective trigger response framework:

- Definition of appropriate measurement endpoints, assessment endpoints, and trigger levels (none, low, and medium action levels) that will enable mitigation of Project-related effects prior to occurrence of irreversible adverse biological effects;
- Define the level of change that may result in irreversible adverse effects (high action level);
- Define the process by which the Project-related effect will be assessed for each of the trigger levels;
- Identify the types of mitigations that may be implemented if a trigger level is exceeded; and
- Define the reporting procedures for exceedances of trigger levels, including the information that will be provided in a response plan.

The triggers for each of the action levels consider the following questions:

- Are AEMP component assessment endpoints changing in ways that were not predicted by models or is mitigation less successful than anticipated (e.g., concentrations of parameters in water higher than predicted by surface water quality model)?

- Are AEMP component assessment endpoints at impact sites changing from background (baseline) or reference ranges (e.g., concentrations higher than the background or reference ranges) as a result of the Project?
- Are AEMP component assessment endpoints at impact sites changing to levels that may be associated with effects (e.g., exceeding a WQG or other benchmark) as a result of the Project?

The flow diagram shown in Figure 6.2-1 shows the questions and general approach to determining the management action level based on results of monitoring under the AEMP, with additional details provided in Sections 6.2.1 to 6.2.5. For each trigger response action level for each AEMP component, potential management responses are also described in Section 6.2.1 to 6.2.5. However, the management actions listed are not exclusive, as the adaptive management framework needs to be flexible enough to enable the tailoring of specific management responses at each action level to the types of actions most likely to address the root cause of the identified changes to the aquatic environment.

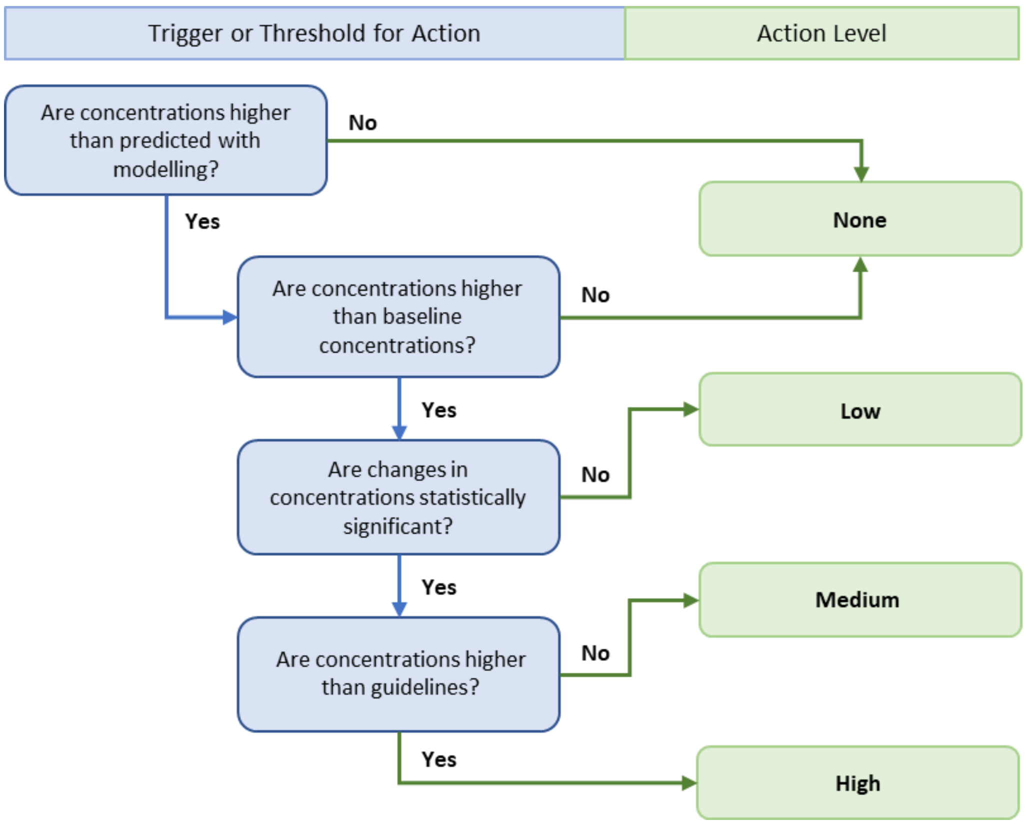

Figure 6.2-1: Flow Diagram of Adaptive Management Triggers and Action Levels

Reporting of the aquatic effects triggers will be completed on an annual basis with management responses intended to ensure continuous improvement and address potential adverse effects over longer time periods.

6.2.1 Water Quality

The selection of water quality parameters to be included in the AEMP trigger response framework begins with the list of parameters routinely monitored and analyzed at the laboratory for the purpose of AEMP water quality monitoring (Table 6.2-1). Parameters were excluded from the list if they represent numerical indicators of water quality or are not constituents of water themselves (i.e., total alkalinity, hardness, ion balance, and specific conductivity) or the parameter is represented by another variable that is carried forward into the AEMP trigger response framework. Rationale for parameters excluded because they are represented by another variable is provided below:

- Turbidity is represented by TSS because it is an alternate measure of the risk represented by TSS.
- Total Kjeldahl Nitrogen is represented by the inclusion of total ammonia-N, which has an established WQG-AL.
- Ortho-phosphorous is represented by the inclusion of total phosphorus, which has a WQG-AL.
- Organic carbon is represented by dissolved oxygen because the risk that is represented by TOC is oxygen deficiency in the water.
- Calcium and magnesium represent hardness that is often a toxicity modifying factor for other parameters. Thus, calcium and magnesium are indirectly included in the development of water quality guidelines.

The next step was to include variables that met the following criteria for assessment in the AEMP trigger response framework:

- Parameters of potential concern and parameters of concern identified in the CSM Report (Appendix 7-B) including fluoride, total and dissolved aluminum, total cadmium, total chromium, total iron, total zinc, nitrogen forms (nitrate, nitrite, ammonia), total phosphorus, and TDS.
- Parameters identified as having uncertainties in predictive modelling that should be monitored (i.e., total mercury).
- Parameters with available BC (BC ENV 2019a, 2021), federal (CCME 2021a) WQG-AL or WQG-WL, or YDWL water quality standards (Table 4.4-2).

Parameters will be excluded in future iterations of the AEMP if parameters are not found to be increasing or predicted to increase.

Based on the criteria for exclusion and inclusion (Table 6.2-1), the following water quality parameters will be included in the AEMP trigger response framework:

- Dissolved oxygen;
- pH;
- TSS and TDS;
- Ions: chloride, fluoride, sulphate;
- Nutrients: total ammonia-N, nitrate-N, nitrite-N, total phosphorus;
- Total metals: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, and zinc; and
- Dissolved metals: aluminum, cadmium, calcium, copper, iron, manganese, and zinc.

For all triggers except those based on the YDWL standards (in progress), the trigger response levels for water quality will be based on near-field sites. The near-field sites represent sites closest to the influence of the mine site discharge points and non-point source seepage. Any effects of the Project on environmental media (surface water, sediment) are likely to be most apparent at the near-field sites, including:

- Davidson Creek: DC-05, DC-10, and DC-15;
- Turtle Creek (only once the airstrip is constructed): TC-05; and
- Creek 661: 661-05 and 661-10.

Table 6.2-1: Selection of Aquatic Effects Monitoring Program Trigger Response Water Quality Parameters

Parameter	Exclusions		Inclusions		AEMP Trigger Response Parameter
	Non-specific Parameters	Represented by Other Variable	Water Quality Guideline[1]	Parameter of Potential Concern[2]	
Physical Parameters and Dissolved Anions					
Conductivity	✓				No
pH			✓		Yes
Total Suspended Solids			✓		Yes
Turbidity		✓			Yes
Total Dissolved Solids			✓	✓	Yes
Hardness (as $CaCO_3$)	✓				No
Total Alkalinity (as $CaCO_3$)	✓				No
Acidity (as $CaCO_3$)	✓				No
Bromide					No
Chloride			✓		Yes
Fluoride			✓	✓	Yes
Sulphate			✓		Yes
Nutrients					
Ammonia (as N)			✓		Yes
Nitrate (as N)			✓	✓	Yes
Nitrite (as N)			✓	✓	Yes
Total Kjeldahl Nitrogen		✓			Yes
Total Phosphorous			✓	✓	Yes
Ortho-phosphorous		✓			Yes
Cyanides					
Total Cyanide			✓		Yes
Cyanide, Weak Acid Dissociable			✓		Yes
Thiocyanate					No
Organic Carbon					
Total Organic Carbon		✓			No
Dissolved Organic Carbon		✓			No
Total and Dissolved Metals					
Aluminum			✓	✓	Yes
Antimony			✓[3]		Yes
Arsenic			✓[3]		Yes
Barium			✓[3]		Yes

Parameter	Exclusions		Inclusions		AEMP Trigger Response Parameter
	Non-specific Parameters	Represented by Other Variable	Water Quality Guideline[1]	Parameter of Potential Concern[2]	
Total and Dissolved Metals *(cont'd)*					
Beryllium			✓[3]		Yes
Bismuth					No
Boron			✓[3]		Yes
Cadmium			✓	✓	Yes
Calcium		✓			No
Chromium			✓[3]	✓	Yes
Cobalt			✓[3]		Yes
Copper			✓		Yes
Iron			✓	✓	Yes
Lead			✓[3]		Yes
Lithium			✓[3]		Yes
Magnesium		✓			No
Manganese			✓[4]		Yes
Mercury			✓[3]		Yes
Molybdenum			✓[3]		Yes
Nickel			✓[3]		Yes
Potassium					No
Selenium			✓[3]		Yes
Silicon					No
Silver			✓[3]		Yes
Sodium					No
Strontium			✓[3]		Yes
Thallium			✓[3]		Yes
Tin					No
Titanium					No
Uranium			✓[3]		Yes
Vanadium			✓[3]		Yes
Zinc			✓	✓	Yes

Notes:

[1] British Columbia Guidelines for the Protection of Freshwater Aquatic Life or Wildlife (ENV 2019a, 2021), Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 2021), or Calculated Class II Standard as defined in Yinka Dene 'Uza'hné Surface Water Management Policy (Nadleh Whut'en and Stellat'en 2016a).

[2] Predicted to be greater than 80% of the federal of BC guideline during the Construction and/or Operations phase.

[3] Available guideline for total metal only.

[4] Available guideline for dissolved metal only.

[5] A Project specific benchmark was proposed at 500 mg/L (Section 6.3.4.3 in the Application).

The YDWL standards for water quality in Class III waters are the lower of the BC provincial (ENV 2019a, 2021) or federal (CCME 2021a) WQG-AL, and apply to the near-field sites in the bullet list above. Class II YDWL standards are based on allocation of up to 50% of the assimilative capacity in the receiving environment and applies to Chedakuz Creek (Sinclair et al 2017). Class I YDWL standards are based on achieving no significant changes from background (baseline) conditions and apply to Tatelkuz Lake and the Nechako Reservoir, among other locations (Sinclair et al. 2017). The implementation of the YDWL is under discussion with the CSFNs; therefore, the use of the YDWL in the Trigger Response Framework will be updated upon completion of the discussions.

The use-protection approach was considered when defining the level of change in concentration of a water quality parameter that could result in irreversible adverse effects; this has the potential to occur at the trigger defined in the high action level. The potential for irreversible adverse effects were defined based on the parameter concentrations that are potentially unsafe to use for wildlife and aquatic life are potentially unable to survive, grow, or reproduce. Where available, water quality triggers have been based on the chronic or long-term WQG-AL, WQG-WL, or SBEBs. The use of guidelines or SBEBs as the trigger at the high action level still provides some conservatism and time to implement mitigation measures to prevent irreversible effects from occurring since WQG-AL, WQG-WL, and SBEBs are still considered to be protective of aquatic and wildlife water uses.

Water quality triggers and management responses to prevent an irreversible adverse effect from occurring in monitored creeks are provided in Table 6.2-2.

Table 6.2-2: Triggers and Management Responses for Water Quality at Near-field Sites

Level	Trigger	Management Response
None	Average monthly measured parameter concentrations in water are: ▪ lower than the WQG-AL, WQG-WL, or SBEB; <u>or</u> ▪ lower than or equal to the 95th percentile baseline concentration plus 20% in the same month; <u>and</u> ▪ less than or equal to the 95th percentile of the predicted concentration (base case) in the same month.	No change to mitigation as mitigation measures are performing as expected, water concentrations are below levels of concern (WQG-AL) or within background or reference ranges, and water quality is in the range predicted by the surface water quality model.
Low	Water concentrations may be increasing in a manner not predicted by the surface water quality model. Average monthly measured parameter concentrations in water in two or more consecutive months are: ▪ lower than the WQG-AL, WQG-WL, or SBEB; <u>or</u> ▪ higher than the 95th percentile baseline concentration plus 20% in the same month; <u>and</u> ▪ higher than 95th percentile of the predicted concentration (base case) for the same month; <u>and</u> ▪ changes in concentration are not statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Identify causes of potential changes in water concentrations so that existing mitigation measures can be adjusted or targeted mitigation measures can be identified for implementation if needed. Additional responses may include: ▪ Plan a water sampling program to define the magnitude, spatial extent, and reversibility of the potential effect; or ▪ Other responses as defined in the AEMP report.

Level	Trigger	Management Response
Medium	Water concentrations are increasing in a manner not predicted by the surface water quality model but are below levels of concern. Average monthly measured water quality concentrations measured parameter concentrations in water in two or more consecutive months are: ▪ lower than the WQG-AL, WQG-WL, or SBEB; <u>or</u> ▪ higher than the 95th percentile baseline concentration plus 20% in the same month; <u>and</u> ▪ higher than 95th percentile of the predicted concentration (base case) for the same month; <u>and</u> ▪ changes in concentration are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Identify causes of potential changes in water concentrations so that targeted mitigation can be identified; ▪ Review and optimize existing mitigation; ▪ Evaluate if new mitigation is feasible and how long it would take to implement; ▪ If nutrient concentrations (nitrogen forms or total phosphorus) are meeting the trigger for medium action level in water, plan a periphyton community composition study as described in Section 4.6; ▪ If metal concentrations are meeting the trigger for medium action level in water, plan a benthic invertebrate tissue metal study as described in Section 4.7 or a water-dependent wildlife study as described in Section 4.9; and ▪ Plan a water sampling program to define the magnitude, spatial extent, and reversibility of the effect. Additional responses may include: ▪ Review the WQG-AL, WQG-WL, or SBEB and identify if a new SBEB is appropriate as new and relevant science becomes available; or ▪ Other responses as defined in the AEMP report.
High	Water concentrations have increased in a manner not predicted by the surface water quality model, are higher than baseline concentrations, and are at levels of concern. Average monthly measured water quality concentrations measured parameter concentrations in water in two or more consecutive months are: ▪ at or higher than of the WQG-AL, WQG-WL, or SBEB; <u>and</u> ▪ higher than the 95th percentile baseline concentration plus 20% in the same month <u>and</u> ▪ greater than 95th percentile of the predicted concentration (base case) for the same month <u>and</u> ▪ changes in concentration are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Confirm root cause of changes in water concentrations and implement new mitigation measures or adjust existing mitigation measures to address root cause; ▪ Implement a water sampling program to define the magnitude, spatial extent, and reversibility of the effect; ▪ If nutrient concentrations (nitrogen forms or total phosphorus) are meeting the trigger for high action level in water, implement a periphyton community composition study as described in Section 4.6 and as developed at the medium action level; ▪ If metal concentrations are meeting the trigger for high action level in water, implement a benthic invertebrate tissue metal study as described in Section 4.7 and as developed at the medium action level or a water-dependent wildlife study as described in Section 4.9 and as developed at the medium action level; and ▪ Implement monitoring to assess effectiveness of mitigation options.

Level	Trigger	Management Response
		Additional responses may include: ■ Evaluate if an ecological risk assessment is required to identify spatial extent, magnitude, and reversibility of the effect; ■ Review the WQG-AL, WQG-WL, or SBEB and propose a new SBEB, if appropriate; or ■ Other responses as defined in the AEMP report.

6.2.2 Sediment Quality

Sediment quality parameters to be included in the AEMP trigger response framework are metals with BC (BC ENV 2019a, 2021) or federal (CCME 2021b) sediment quality guidelines, in addition to TOC and particle size. The metals with SQGs include: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc.

As described for water quality (Section 6.2.1), spatially, the trigger response levels for sediment quality will be applied to near-field sites only. Any effects of the Project on environmental media (surface water, sediment) are likely to be most apparent at the near-field sites, including:

- Davidson Creek: DC-05, DC-10, and DC-15;
- Turtle Creek (only once the airstrip is constructed): TC-05; and
- Creek 661: 661-05 and 661-10.

The use-protection approach was considered when defining the level of change in concentration of a sediment quality parameter that could result in irreversible adverse effects; this has the potential to occur at the trigger defined in the high action level. Irreversible adverse effects were defined based on the parameter concentrations where sediment metal concentrations are at a level where aquatic life are potentially unable to survive, grow, or reproduce. Where available, sediment triggers have been based on the most conservative SQG (the lower SQG from BC and the ISQG from CCME; BC ENV 2019a, 2021, CCME 2021b). The use of the SQG as the trigger at the high action level still provides some conservatism and time to implement mitigation measures to prevent irreversible effects from occurring since SQGs are still considered to be protective of aquatic water uses. Particle size and TOC in sediments do not have available SQGs; thus, only a comparison to background (baseline) or reference conditions will be completed.

Sediment quality triggers and management responses to prevent an irreversible adverse effect from occurring in monitored creeks are provided in Table 6.2-3.

Table 6.2-3: Triggers and Management Responses for Sediment Quality

Level	Trigger	Management Response
None	Average annual measured sediment concentrations are: ■ lower than the sediment quality guideline (SQG); <u>or</u> ■ lower than or equal to the 95th percentile baseline concentration (background or reference range).	No change to mitigation as mitigation measures are performing as expected. Sediment concentrations are well below levels of concern (SQGs) or are within the background or reference range.

Level	Trigger	Management Response
Low	Sediment concentrations may be changing from background concentrations. Average annual measured sediment concentrations are: ▪ lower than the SQG; or ▪ higher than the 95th percentile baseline concentration; and ▪ changes in concentration are not statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Identify potential causes of changes in sediment concentrations so that targeted mitigation measures can be identified for implementation. Additional responses may include: ▪ Plan a sampling program to define the magnitude, spatial extent, and reversibility of the effect; ▪ Review the SQG as new and relevant science becomes available; or ▪ Other responses as defined in the AEMP report.
Medium	Sediment concentrations are changing from background concentrations but are below levels of concern. Average annual measured sediment concentrations are: ▪ lower than the SQG; and ▪ higher than the 95th percentile baseline concentration; and ▪ changes in concentration are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Identify causes of potential changes in sediment concentrations so that targeted mitigation can be identified; ▪ Review and optimize existing mitigation; ▪ Evaluate if new mitigation is feasible and how long it would take to implement; ▪ Increase sediment monitoring frequency by one year (e.g., from every three years to every two years) if frequency is less than once per year; ▪ Plan a sediment sampling program to define the magnitude, spatial extent, and reversibility of the effect; ▪ If metal concentrations are meeting the trigger for medium action level in sediment, plan a sediment toxicity study, as defined in Section 4.5.2; and ▪ If metal concentrations are meeting the trigger for medium action level in sediment, plan a benthic invertebrate tissue metal study as described in Section 4.7. Additional responses may include: ▪ Review the SQG as new and relevant science becomes available; or ▪ Other responses as defined in the AEMP report.
High	Sediment concentrations are higher than baseline concentrations and are at levels of concern. Average annual measured sediment concentrations are: ▪ at or higher than the SQG; and ▪ greater than the 95th percentile baseline concentration; and ▪ changes in concentration are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Confirm root cause of changes in concentrations and implement new mitigation measures or further adjust existing mitigation measures to address root cause; ▪ Increase monitoring frequency by one year (e.g., from every three years to every two years) if frequency is less than once per year; ▪ Implement a sediment sampling program to define the magnitude, spatial extent, and reversibility of the effect; ▪ If metal concentrations are meeting the trigger for medium action level in sediment, implement a sediment toxicity study, as defined in Section 4.5.2 and as developed at the medium action level;

Level	Trigger	Management Response
		■ If metal concentrations are meeting the trigger for high action level in sediment, implement a benthic invertebrate tissue metal study as described in Section 4.7 and as developed at the medium action level; and ■ Implement monitoring to assess effectiveness of mitigation options. Additional responses may include: ■ Evaluate if an ecological risk assessment is required to identify spatial extent, magnitude, and reversibility of the effect; ■ Review the SQG as new and relevant science becomes available; or ■ Other responses as defined in the AEMP report.

6.2.3 Periphyton

Periphyton assessment endpoints to be included in the AEMP trigger response framework are based on chlorophyll *a* (BC ENV 2019a) WQG-AL.

As described for water quality (Section 6.2.1) and sediment quality (Section 6.2.2), spatially, the trigger response levels for chlorophyll *a* will be applied to near-field sites only. Any effects of the Project on aquatic biota are likely to be most apparent at the near-field sites, including:

- Davidson Creek: DC-05 and DC-15;
- Turtle Creek (only once the airstrip is constructed): TC-05; and
- Creek 661: 661-05 and 661-10.

The use-protection approach was considered when defining the chlorophyll *a* concentration that could result in irreversible adverse effects; this has the potential to occur at trigger defined in the high action level. Irreversible adverse effects were defined based on the chlorophyll *a* concentrations where aquatic life or fish habitats are potentially affected due to overabundance of periphyton. The use of the chlorophyll *a* WQG-AL as the trigger at the high action level still provides some conservatism and time to implement mitigation measures to prevent irreversible effects from occurring since the WQG-AL is still considered to be protective of aquatic water uses.

Periphyton triggers and management responses to prevent an irreversible adverse effect from occurring in monitored creeks are provided in Table 6.2-4.

Table 6.2-4: Triggers and Management Responses for Periphyton (Chlorophyll *a*)

Level	Trigger	Management Response
None	Average annual measured chlorophyll *a* concentrations are: ■ Lower than the chlorophyll *a* WQG-AL; <u>or</u> ■ Lower than or equal to the 95th percentile baseline concentration of chlorophyll *a* (background or reference range).	No change to mitigation as mitigation measures are performing as expected. Chlorophyll *a* concentrations are below levels of concern (WQG-AL) or are within the background or reference range.

Level	Trigger	Management Response
Low	Chlorophyll *a* concentrations may be changing from baseline concentrations. Average annual measured chlorophyll *a* concentrations are: ■ Lower than the chlorophyll *a* WQG-AL; <u>and</u> ■ Higher than the 95th percentile baseline concentration of chlorophyll *a*; <u>and</u> ■ changes in chlorophyll a concentration are not statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ■ Identify potential causes of changes in chlorophyll *a* concentrations so that targeted mitigation measures can be identified for implementation Responses may include: ■ Plan a collection program to define the magnitude, spatial extent, and reversibility of the effect; or ■ Other responses as defined in the AEMP report.
Medium	Chlorophyll *a* concentrations are changing from baseline concentrations but are below levels of concern. Average annual measured chlorophyll *a* concentrations are: ■ Lower than the chlorophyll *a* WQG-AL; <u>and</u> ■ Higher than the 95th percentile baseline concentration of chlorophyll *a*; <u>and</u> ■ changes in chlorophyll *a* concentration are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses may include: ■ Identify causes of potential changes in chlorophyll *a* concentrations so that targeted mitigation can be identified; ■ Review and optimize existing mitigation; ■ Evaluate if new mitigation is feasible and how long it would take to implement; ■ Plan a chlorophyll *a* sampling program to define the magnitude, spatial extent, and reversibility of the effect; ■ Increase monitoring frequency by one year (e.g., from every three years to every two years) if frequency is less than once per year; and ■ Plan a periphyton community composition study, as defined in Section 4.6 Additional responses may include: ■ Review the chlorophyll *a* WQG-AL as new and relevant science becomes available; or ■ Other responses as defined in the AEMP report.
High	Chlorophyll *a* concentrations are higher than baseline concentrations and are at levels of concern. Average annual measured chlorophyll *a* concentrations are: ■ higher than the chlorophyll *a* WQG-AL; <u>and</u> ■ Higher than the 95th percentile baseline concentration of chlorophyll *a*; <u>and</u> ■ changes in chlorophyll *a* concentration are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ■ Confirm root cause of changes in concentrations and implement new mitigation measures or further adjust existing mitigation measures to address root cause; ■ Increase monitoring frequency by one year (e.g., from every three years to every two years) if frequency is less than once per year; ■ Implement a periphyton community composition study, as defined in Section 4.6 and as developed at the medium action level; and ■ Implement monitoring to assess effectiveness of mitigation options. Additional responses may include, but are not limited to: ■ Evaluate if an ecological risk assessment is required to identify spatial extent, magnitude, and reversibility of the effect; ■ Review the chlorophyll *a* WQG-AL as new and relevant science becomes available; or ■ Other responses as defined in the AEMP report.

6.2.4 Aquatic Invertebrates

Benthic invertebrate measurement endpoints to be included in the AEMP trigger response framework are based on abundance and taxonomy (community composition). Specifically, the "indicators" described as the triggers in Table 6.2-5 for aquatic invertebrates include benthic invertebrate abundance, family richness, Simpson's Diversity and Evenness indices, and the Bray-Curtis Index (similarity index).

Table 6.2-5: Triggers and Management Responses for Aquatic Invertebrates

Level	Trigger	Management Response
None	Aquatic invertebrate indicators (abundance, family richness, Simpson's Diversity and Evenness indices, and Bray-Curtis index) are unchanged from baseline conditions and there is no change in the similarity to reference communities using the reference condition analysis.	No change to mitigation as mitigation measures are performing as expected. Aquatic invertebrate indicators are within the background or reference range.
Low	Aquatic invertebrate indicators may be changing from baseline conditions but are not yet at levels of concern (defined by the dissimilarity from the predictive CABIN reference site model). Aquatic invertebrate indicators are similar to reference conditions but the results of the reference condition analysis suggest that potential shifts in community indicating there is a stressor at the near-field site.	Responses will include: ▪ Identify potential causes of changes in aquatic invertebrate indicators (e.g., changes in hydrograph) to identify targeted mitigation measures for implementation. Responses may include: ▪ Plan a collection program to define the magnitude, spatial extent, and reversibility of the effect; or ▪ Other responses as defined in the AEMP report.
Medium	Aquatic invertebrate indicators are changing from baseline conditions and changes may be at levels of concern (defined by the dissimilarity from the predictive CABIN reference site model). Aquatic invertebrate abundance and community composition indicators are increasingly dissimilar and highly divergent from the reference communities based on the reference condition analysis.	Responses will include: ▪ Identify causes of potential changes in aquatic invertebrate indicators so that targeted mitigation can be identified; ▪ Review and optimize existing mitigation; ▪ Evaluate if new mitigation is feasible; and how long it would take to implement. ▪ Plan a sampling program to define the magnitude, spatial extent, and reversibility of the effect; ▪ If changes in sediment metal concentrations are identified as a potential cause of the changes in aquatic invertebrate indicators, plan a sediment toxicity testing study, as defined in Section 4.5.2; ▪ Increase monitoring frequency by one year (e.g., from every three years to every two years) if frequency is less than once per year. Any additional responses will be defined in the AEMP report.
High	Aquatic invertebrate community composition indicators are changing from baseline conditions and changes are at levels of concern (defined by the dissimilarity from the predictive CABIN reference site model).	Responses will include: ▪ Confirm root cause of changes in community composition and implement new mitigation measures or further adjust existing mitigation measures to address root cause;

Level	Trigger	Management Response
	Aquatic invertebrate community composition indicators are increasingly dissimilar and highly divergent from the reference communities based on the reference condition analysis in two or more consecutive sampling events; and community changes are trending to losses of EPT (pollution sensitive taxa) taxa or taxa representing an important fish or other invertebrate food source.	■ Implement a sampling program to define the magnitude, spatial extent, and reversibility of the effect; ■ Implement a sediment toxicity testing study, as defined in Section 4.5.2 and as developed at the medium action level; ■ Increase monitoring frequency by one year (e.g., from every three years to every two years) if frequency is less than once per year; ■ Implement monitoring to assess effectiveness of mitigation options. Additional responses may include: ■ Evaluate if additional monitoring and an ecological risk assessment is required to identify spatial extent, magnitude, and reversibility of the effect; or ■ Other responses as defined in the AEMP report.

As described for water quality (Section 6.2.1), sediment quality (Section 6.2.2), and aquatic primary producers (Section 6.2.3), spatially, the trigger response levels for aquatic invertebrates will be applied to near-field sites only. Any effects of the Project on aquatic biota are likely to be most apparent at the near-field sites, including:

- Davidson Creek: DC-05 and DC-15;
- Turtle Creek (only once the airstrip is constructed): TC-05; and
- Creek 661: 661-05 and 661-10.

The use-protection approach was considered when defining the assessment endpoints for each trigger level. Abundance is considered appropriate for high level changes in biological communities. Changes in community composition (family richness, Simpson’s Diversity and Evenness indices, or Bray-Curtis index) can vary in their ecological significance given the importance of a group as food resource for fish or other invertebrates, or known tolerance of the group to disturbance. Thus, losses of EPT (pollution sensitive taxa) taxa or taxa representing an important fish or other invertebrate food source is expected to result in adverse effects.

Aquatic invertebrate triggers and management responses to prevent an irreversible adverse effect from occurring in monitored creeks are provided in Table 6.2-5.

6.2.5 Fish Tissue Metals

Triggers for fish community metrics (e.g., abundance, density, and population structure) and fish health metrics (e.g., length, weight, and condition factor) have not been included in this framework.
These metrics are highly variable temporally and spatially. The methods used to assess these metrics are also highly variable, depending on local environmental conditions (e.g., weather, time of day, stream discharge, turbidity). Given the high variability of the metrics, establishment of specific thresholds and triggers for action is not feasible. Instead, reliance on fish habitat metrics (i.e., temperature, water chemistry, and hydrology) and fish tissue metal levels to establish actionable triggers is proposed.

Fish tissue metal parameters to be included in the AEMP trigger response framework are metals with BC WQG-AL for fish tissue, which includes selenium (Beatty and Russo 2014) and mercury (BC MOE 2001b). Mercury in fish tissue was also identified as a POC for monitoring in the CSM Report

(Appendix 7-B) due to uncertainties in surface water quality model predictions. Including mercury in fish tissue in the adaptive response framework will help to address uncertainties associated with the surface water quality and fish tissue model predictions for mercury.

As described for other chemistry-based components such as water quality (Section 6.2.1), sediment quality (Section 6.2.2), and chlorophyll *a* (Section 6.2.3), spatially, the trigger response levels for fish tissue metal concentrations will be applied to near-field sites only. Any effects of the Project on aquatic biota are likely to be most apparent at the near-field sites, including:

- Davidson Creek: DC-05 and DC-15;
- Turtle Creek (only once the airstrip is constructed): TC-05; and
- Creek 661: 661-05 and 661-10.

The use-protection approach was considered when defining the fish tissue metal concentrations that could result in irreversible adverse effects; this has the potential to occur at trigger levels defined in the high action level. Irreversible adverse effects were defined based on the concentration where fish tissue selenium or mercury concentrations are at a level where potential effects may begin to occur in either fish or wildlife consumers of fish. The use of the WQG-AL for fish tissue for selenium and mercury as the trigger at the high action level still provides some conservatism and time to implement mitigation measures to prevent irreversible effects from occurring since the WQG-AL is still considered to be protective of fish and wildlife water uses.

Fish tissue selenium and mercury concentration triggers and management responses to prevent an irreversible adverse effect from occurring in aquatic life or wildlife are provided in Table 6.2-6.

Table 6.2-6: Triggers and Management Responses for Fish Tissue Metal Concentrations

Level	Trigger	Management Response
None	Average annual fish tissue concentrations of selenium and mercury are: ▪ lower than the WQG-AL for selenium or mercury in fish tissue; <u>or</u> ▪ lower than or equal to the 95th percentile baseline concentration of fish tissue concentrations for selenium and mercury (background or reference range).	No change to mitigation as mitigation measures are performing as expected. After two cycles of monitoring with no statistically significant effects, decrease sampling frequency to once every six years.
Low	Fish tissue concentrations may be changing from baseline concentrations. Average annual fish tissue concentrations of selenium and mercury are: ▪ below the WQG-AL for selenium or mercury in fish tissue; <u>and</u> ▪ higher than the 95th percentile baseline concentration for selenium or mercury in fish tissue; <u>and</u> ▪ changes in selenium or mercury in fish tissue concentrations are not statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).	Responses will include: ▪ Identify potential causes of changes in fish tissue concentrations so that targeted mitigation measures can be identified for implementation. Responses may include: ▪ After two cycles of monitoring with no statistically significant effects, decrease sampling frequency to once every six years ▪ Plan a collection program to define the magnitude, spatial extent, and reversibility of the effect; or ▪ Other responses as defined in the AEMP report.

<table>
<tr><th>Level</th><th>Trigger</th><th>Management Response</th></tr>
<tr><td>Medium</td><td>Fish tissue concentrations are changing from baseline concentrations. Average annual fish tissue concentrations of selenium and mercury are:
■ Lower than the WQG for selenium or mercury in fish tissue;
and
■ Higher than the 95th percentile baseline concentration for selenium or mercury in fish tissue;
and
■ changes in selenium or mercury concentrations in fish tissue are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).</td><td>Responses may include:
■ Increase monitoring frequency to once every three years;
■ Identify causes of potential changes in fish tissue concentrations so that targeted mitigation can be identified;
■ Review and optimize existing mitigation;
■ Evaluate if new mitigation is feasible and how long it would take to implement; and
■ Plan a fish tissue concentrations sampling program to define the magnitude, spatial extent, and reversibility of the effect.
Additional responses may include:
■ Review the fish tissue WQG-AL as new and relevant science becomes available; or
■ Other responses as defined in the AEMP report.</td></tr>
<tr><td>High</td><td>Fish tissue concentrations are higher than baseline concentrations and are at levels of concern. Average annual fish tissue concentrations of selenium and mercury are:
■ higher than the WQG for selenium or mercury in fish tissue;
and
■ Higher than the 95th percentile baseline concentration for selenium or mercury in fish tissue;
and
■ changes in selenium or mercury concentrations in fish tissue are statistically significant between near-field and reference sites or compared to baseline conditions (BACI analysis).</td><td>Responses will include:
■ Increase monitoring frequency to once every three years;
■ Confirm root cause of changes in fish tissue concentrations and implement new mitigation measures or further adjust existing mitigation measures to address root cause; and
■ Implement monitoring to assess effectiveness of mitigation options.
Additional responses may include:
■ Evaluate if an ecological risk assessment is required to identify spatial extent, magnitude, and reversibility of the effect;
■ Review the fish tissue WQG-AL as new and relevant science becomes available; or
■ Other responses as defined in the AEMP report.</td></tr>
</table>

7. REPORTING

7.1 Interaction with Other Monitoring Plans

Results of the AEMP will inform the CFMP, which is required by EAC Condition 41. Specifically, surface water quality and fish tissue metal data collected under the AEMP will be used in the CFMP to fulfill the requirements for water quality sampling (EAC Condition 41(d)(vii)) and fish tissue sampling (EAC Condition 41(d)(vi)). As required by EAC condition 41(d)(vi)(i), fish tissue and surface water quality samples will be co-collected at the same site and at the same time, as described in the Field Methods under Section 4.8.1.2. Under the CFMP, these data will be used to determine whether Project-related changes to country foods or human health are likely to occur. Triggers based on surface water quality and fish tissue metal concentrations will be defined in the CFMP as part of the adaptive management framework for the CFMP.

7.2 Aquatic Effects Monitoring Program Reports

7.2.1 Technical Report

An AEMP report will be generated for each year in which data are collected under the AEMP. The report will include all data collected within a given calendar year, with the report completed for submission to Indigenous nations, the Environmental Monitoring Committee (EMC), regulators including ENV, EAO, EMLI, and FLNRORD by March 31 of the following year.

At minimum, each annual AEMP Report will include data and analysis of water quality, hydrology, and temperature data because these AEMP components will be sampled regularly or monitored continuously each year. Initially, the full AEMP sampling program (i.e., all standard components, not including triggered components) is anticipated to be completed on an annual basis for the first three years, beginning in the first year of Construction phase. Thereafter, if no significant effects are identified in assessment endpoints of sediment quality, aquatic primary producers, or aquatic invertebrates, sampling (and reporting) for these components will decrease by one year for each three-year period where no significant effects are identified. The minimum sampling frequency is once every three years, and sampling frequency will be increased by one year if significant adverse effects are identified up to a maximum of annual sampling. Fish tissue sampling frequency will be decreased to once every six years after two successive cycles in which no effects are identified (with an increase in frequency to once every three years if effects were identified). Thus, after the first three years of AEMP reporting, the AEMP report will only include sediment quality, aquatic primary producers, aquatic invertebrates, or fish community AEMP community components in years in which they are sampled. Kokanee community sampling will initially be conducted on an annual basis for at least the first eight years of Operations, to ensure that two complete kokanee cohort generations are assessed. Beyond the eight-year mark, survey frequency for fish community may be reduced to once every two years, if no trend in fish community is observed.

The AEMP Report will include a summary of field and laboratory methods, data, analysis and results, and the status of each assessment endpoint in the adaptive management framework (none, low, medium, high). Summary statistics of the baseline conditions (e.g., water quality parameter concentration, fish tissue metal concentration) used for the purpose of the adaptive management framework will be provided. When a trigger action level (low, medium, high) is met, this will be identified in the AEMP report for that reporting period. The AEMP report will also document the specific steps or actions identified to respond to the trigger and the timelines for when the responses will be implemented.

As part of each annual report, the AEMP sampling plan, analysis, and adaptive management framework will be reviewed to evaluate the effectiveness of the plan and ensure that the objectives defined in

Section 1.1 are being met. This may include updates to the sampling plan to address potential effects related to emergencies and/or temporary shutdowns. The annual AEMP report will include any recommendations for changes to the scope or timing of the AEMP sampling, including rationale for any recommended changes.

7.2.2 Decision Statement Annual Reporting and Information Sharing

DS Conditions 2.11, 2.12 and 2.13 set out annual reporting requirements related to the implementation of conditions in the DS. Condition 2.14 sets out information sharing requirements related to the annual reports. Reporting will commence when BW Gold begins to implement the conditions set out in the DS. Requirements in DS Conditions 2.11 to 2.14 are presented below.

DS Condition 2.11 requires:

> *"The Proponent [BW Gold] shall, commencing in the reporting year during which the Proponent begins the implementation of the conditions set out in this Decision Statement, prepare an annual report that sets out:*
>
> *2.11.1 the activities undertaken by the Proponent in the reporting year to comply with each of the conditions set out in this Decision Statement;*
> *2.11.2 how the Proponent complied with condition 2.1;*
> *2.11.3 for conditions set out in this Decision Statement for which consultation is a requirement, how the Proponent considered any views and information that the Proponent received during or as a result of the consultation, including a rationale for how the views have, or have not, been integrated;*
> *2.11.4 the information referred to in conditions 2.5 and 2.6 for each follow-up program;*
> *2.11.5 the results of the follow-up program requirements identified in conditions 3.14, 3.15, 3.16, 4.5, 5.5, 6.11, 6.12, 6.13, 6.14, 8.18.6, 8.20.5, 8.21, and 8.22 if required;*
> *2.11.6 any update made to any follow-up program in the reporting year;*
> *2.11.7 any modified or additional mitigation measures implemented or proposed to be implemented by the Proponent, as determined under condition 2.9 and rationale for why mitigation measures were selected pursuant to condition 2.5.4; and*
> *2.11.8 any change(s) to the Designated Project in the reporting year."*

DS Condition 2.12 requires: *"The Proponent [BW Gold} will provide the draft annual report to Indigenous groups, no later than June 30 following the reporting year to which the annual report applies. BW Gold will consult Indigenous groups on the content and findings in the draft annual report."*

DS Condition 2.13 requires: *"The Proponent [BW Gold], in consideration of any comments received from Indigenous groups pursuant to condition 2.12 shall revise and submit to the Agency [Impact Assessment Agency of Canada] and Indigenous groups a final annual report, including an executive summary in both official languages, no later than September 30 following the reporting year to which the annual report applies."*

DS Condition 2.14 requires: *"The Proponent [BW Gold] shall publish on the Internet, or any medium which is publicly available, the annual reports and the executive summaries referred to in conditions 2.11 and 2.13.*

The Proponent shall keep these documents publicly available for 25 years following the end of decommissioning of the Designated Project. The Proponent shall notify the Agency and Indigenous groups of the availability of these documents within 48 hours of their publication."

DS Condition 2.15 requires: "*When the development of any plan is a requirement of a condition set out in this Decision Statement, the Proponent [BW Gold] shall submit the plan to the Agency and to Indigenous groups prior to construction, unless otherwise required through the condition.*"

7.2.3 Environmental Assessment Certificate Reporting

Condition 5 of the EAC sets out reporting requirements. BW Gold must submit a report to the attention of the EAO and Aboriginal Groups on the status of compliance with EAC #M19-01 at the following times:

a. at least 30 days prior to the start of Construction;

b. on or before March 31 in each year after the start of Construction;

c. at least 30 days prior to the start of Operations;

d. on or before March 31 in each year after the start of Operations;

e. at least 30 days prior to the start of Closure;

f. on or before March 31 in each year after the start of Closure until the end of Closure;

g. at least 30 days prior to the start of Post-Closure; and

h. on or before March 31 in each year after the start of Post-Closure until the end of Post-Closure.

BW Gold will submit reports to the EAO and Aboriginal Groups within the timelines specified in Condition 5.

7.2.4 Plain Language Report

In addition to the detailed technical report described in Section 6.2.1, an AEMP executive summary-style report written in manner understandable to a lay audience will be provided. The intent of this short report will be to provide a high-level overview of the AEMP data, results, and conclusions in an easier to understand, plain language format, as required by EAC Condition Section 30(j).

8. QUALIFIED PROFESSIONALS

As required by Condition 30 of the EAC, the AEMP was prepared by qualified professionals, as shown on the signature page below. A qualified professional is a person who has training, experience, and expertise in a discipline relevant to the field of practice set out in the condition, is registered with a professional organization enabled under an Act who must follow a code of ethics issued by the professional organization, perform her or his duties in the public interest, and can be subject to disciplinary action by the organization.

Prepared by:

Lesley Shelley, Ph.D., R.P.Bio. (#2635)

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ATTACHMENT A CONCORDANCE WITH ENVIRONMENTAL ASSESSMENT CERTIFICATE #M19-01 (JUNE 21, 2019)

Attachment A: Concordance of EAC #M19-01 Conditions with the Aquatic Effects Monitoring Program Plan

Environmental Assessment Certificate	Section in the Aquatic Effects Monitoring Program Plan
Condition 30: Aquatic Effects Monitoring Plan	
The Holder must retain a Qualified Professional to develop an Aquatic Effects Monitoring Plan (AEMP).	Section 8
The AEMP must be developed in consultation with EMPR, ENV, FLNRORD, and Aboriginal Groups.	Section 2; Ongoing
The AEMP must include at least the following:	
a) a description of how the plan takes into consideration the YDWL and any other Aboriginal water policies made available to the Holder by the Aboriginal Groups;	Section 1.3 (BW Gold has been collaborating with the Carrier Sekani First Nations (CSFNs) in regards to implementation of the YDWL and discussions with the CSFNs are ongoing.)
b) a description of the Project, associated activities, and study area;	Section 1, Section 4
c) a conceptual model that describes the relationships between mining-related activities and potential effects on the aquatic environment;	Section 1.5
d) a description of the water quality issues and concerns with respect to the Project that exist in the vicinity of the Project Site;	Section 3
e) the objectives and a list of questions the AEMP is intended to answer;	Section 1.1 and Section 4
f) a detailed description of the design of the monitoring program, including a list of assessment endpoints (for example, survival, growth, and reproduction of fish in receiving waters) and measurement endpoints (for example, surface water chemistry) that will be incorporated into the AEMP;	Section 4 (tables 4.3-1, 4.4-1, 4.4-2, 4.4-4, 4.5-1, 4.6-1, 4.7-1, 4.8-1, 4.8-2, 4.8-4, 4.8-6, and 4.9-1)
g) a description of the locations, timing, and frequency of sampling for each of the measurement endpoints and metrics (e.g., concentrations of major ions in surface water) that will be included in the AEMP, including those for surface water chemistry, surface water toxicity, sediment chemistry, sediment toxicity, tissue chemistry, aquatic plant communities, aquatic invertebrate communities, fish communities, and aquatic-dependent wildlife communities;	Section 4.2 (Table 4.2-2); see Section 4.6.1 for why aquatic plant communities are excluded
h) the means by which the data collected under the AEMP will be analyzed to determine the effects of the Project on the aquatic environment;	Section 4
i) means by which the AEMP will inform the Country Foods Monitoring Plan (Condition 41);	Section 7.1
j) a list of reports that will be prepared to disseminate the results of the AEMP, including a description of the proposed frequency, timing, structure, and content of each report. The reports must include a report that summarizes the results of the AEMP in language understandable to a lay audience; and	Section 7.2

Environmental Assessment Certificate	Section in the Aquatic Effects Monitoring Program Plan
k) the process and timing for sharing monitoring and study results, including the reports required under paragraph (j), with ENV, EMPR, FLNRORD, Aboriginal Groups and the EMC.	Section 7.2
The adaptive management aspect of this plan, as required under Condition 3, may be in a stand-alone section of this plan.	Section 6
The Holder must provide the draft plan that was developed in consultation with EMPR, ENV, FLNRORD, and Aboriginal Groups to EAO, EMPR, ENV, FLNRORD, and Aboriginal Groups for review a minimum of 60 days prior to the planned commencement of Construction or as listed in the Document Submission Plan required by Condition 10 of this Certificate.	Ongoing
The AEMP, and any amendments thereto, must be implemented to the satisfaction of a Qualified Professional throughout Construction, Operations, Closure and Post-Closure and to the satisfaction of the EAO.	Ongoing
Condition 2: Plan Development	
Where a condition of this Certificate requires the Holder to develop a plan, program or other document, any such plan, program or other document must, at a minimum, include the following information:	
a) purpose and objectives of the plan, program or other document;	Section 1.1
b) roles and responsibilities of the Holder and Employees;	Section 1.2
c) names and, if applicable, professional certifications and professional stamps/seals, of those responsible for the preparation of the plan, program, or other document;	Section 8
d) schedule for implementing the plan, program or other document throughout the relevant Project phases;	Section 4
e) means by which the effectiveness of the mitigation measures will be evaluated including the schedule for evaluating effectiveness;	Section 6
g) schedules and methods for the submission of reporting to specific agencies, Aboriginal Groups and the public and the required form and content of those reports; and	Section 7
h) process and timing for updating and revising the plan, program or other document, including any consultation with agencies and Aboriginal Groups that would occur in connection with such updates and revisions.	Section 2
Condition 3: Adaptive Management	
Where a condition of this Certificate requires the Holder to develop a plan, program or other document that includes monitoring, including monitoring of mitigation measures or monitoring to determine the effectiveness of the mitigation measures, the Holder must include adaptive management in that plan.	Section 6
The objective of the adaptive management is to address the circumstances that will require the Holder to implement alternate or additional mitigation measures to address effects of the Project if the monitoring shows that those effects:	
a) are not mitigated to the extent contemplated in the Application;	Section 6.2
b) are not predicted in the Application; or	
c) have exceeded the triggers identified in paragraph g) of this condition.	

Environmental Assessment Certificate	Section in the Aquatic Effects Monitoring Program Plan
The adaptive management in the plan must include at least the following:	
d) the monitoring program that will be used including methods, location, frequency, timing and duration of the monitoring;	Section 4
e) the baseline information that will be used, or collected where existing baseline information is insufficient, to support the monitoring program;	Section 6.2
f) the scope, content and frequency of reporting of the monitoring results;	Section 7
g) the identification of qualitative and quantitative triggers, which, when observed through monitoring required under paragraph d), will require the Holder to alter existing, or develop new, mitigation measures to avoid, reduce, and/or remediate effects;	Section 6.2 (tables 6.2-2, 6.2-3, 6.2-4, 6.2-5, 6.2-6)
h) the methods that will be applied to detect when a numeric trigger, or type or level of change referred to in paragraph g), has occurred;	
i) a description of the process for and timing to alter existing mitigation measures or develop new mitigation measures to reduce or avoid effects;	
j) identification of the new and/or altered mitigation measures that will be applied when any of the changes identified in paragraphs a) to c) occur, or the process by which those will be established and updated over the relevant timeframe for the specific condition;	
k) the monitoring program that will be used to determine if the altered or new mitigation measures and/or remediation activities are effectively mitigating or remediating the effects and or avoiding potential effects; and,	
l) the scope, content and frequency of reporting on the implementation of altered or new mitigation measures.	Section 7
If there are any requirements or mitigation measures required in the plan, program or other document for which adaptive management, or elements of adaptive management listed in paragraphs d) to l) are assessed to be not appropriate or applicable, the plan must include identification of those requirements and measures, and the rationale for that assessment.	Ongoing
Condition 26: Water Quality Management	
a) During Construction, Operations, Closure, and Post-Closure, the Holder must ensure the Project does not cause downstream water quality to exceed BC Water Quality Guidelines, unless the Holder has developed and ENV has accepted one or more Science Based Environmental Benchmarks (SBEBs), in which case the accepted SBEB must not be exceeded. Downstream water quality includes water quality in, at a minimum, Davidson Creek and Creek 661, as monitored in accordance with paragraph (d) of this Condition.	Section 5: Water quality endpoints have not been included in a trigger action response plan because as part of the Mine Site Water and Discharge Monitoring and Management Plan (Appendix 9-E) effluent water will meet BC WQG-AL or approved SBEBs prior to discharge to the receiving environment

Environmental Assessment Certificate	Section in the Aquatic Effects Monitoring Program Plan
b) If the Holder develops SBEBs, these must be developed: i) in consultation with ENV and Aboriginal Groups; ii) in accordance with ENV's "A Framework for the Development and Use of Freshwater Science-Based Environmental Benchmarks for Aquatic Life in Environmental Management Act Permitting for Mines" (March 2016, or as updated or replaced from time to time); and iii) in consideration of Yinka Dene Water Law (YDWL) for Davidson Creek, and in consideration of any other water policies from Aboriginal Groups made available to the Holder for Davidson Creek and/or Creek 661; and submitted to the EAO, ENV and Aboriginal Groups within the time set out in Condition 10, the Document Submission Plan.	*Appendix 5-E*
c) If the Holder develops SBEBs, the Holder must produce a report that clearly documents how the YDWL and any other Aboriginal water policies referenced in paragraph b) iii) were considered in the development of SBEBs. Where site specific standards or metrics for YDWL for Davidson Creek or another Aboriginal Group's water policies for Davidson Creek and/or Creek 661 are made available to the Holder, the report must include a comparison of how the SBEB compares to those standards or metrics. The report must be provided to ENV, EMPR, EAO, and Aboriginal Groups in accordance with the time set out in Condition 10, the Document Submission Plan, and be to the satisfaction of the EAO.	*Appendix 5-E*
d) The Holder must monitor surface water quality at a location(s) determined by a Qualified Professional, in consultation with EMPR, ENV, and Aboriginal Groups.	Table 4.4-1 (sample locations) and Table 4.4-2 (monitoring frequency); Section 4.4-2
Condition 28: Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan	
The Holder must retain a Qualified Professional to develop a surface water quality monitoring plan for Tatelkuz Lake and Chedakuz Creek upstream of the Nechako Reservoir. The plan must be developed in consultation with Aboriginal Groups, ENV and EMPR. The plan must include at least the following:	Section 8
a) monitoring locations;	Attachment B
b) frequency of monitoring;	
c) the means by which the baseline information in Condition 27, Water Quality Report, and any other appropriate information or criteria as determined by a Qualified Professional, will be used to determine if there are adverse effects due to the Project to: i) Tatelkuz Lake; and ii) Chedakuz Creek upstream of Nechako Reservoir;	
d) how the Holder has considered YDWL, other Aboriginal policies made available to the Holder from Aboriginal Groups, and ENV guidance in development of the criteria in paragraph c);	
e) conditions, if any, under which monitoring would no longer be required; and	

Environmental Assessment Certificate	Section in the Aquatic Effects Monitoring Program Plan
f) the means by which the Holder will communicate this information to Aboriginal Groups, including identification of the type of information to be provided, the frequency of reporting and the implications of the water quality observed at Chedakuz Creek for the Nechako Reservoir. Reports must include a summary written for a lay audience.	
The Holder must provide this draft plan that was developed in consultation with Aboriginal Groups, ENV and EMPR to the EAO, ENV, EMPR and Aboriginal Groups a minimum of 60 days prior to the planned commencement of Construction, or as or as listed in the Document Submission Plan required by Condition 10 of this Certificate. The plan, and any amendments thereto, must be implemented to the satisfaction of a Qualified Professional throughout Operations, Closure and Post-Closure, and to the satisfaction of the EAO.	

ATTACHMENT B CHEDAKUZ CREEK AND TATELKUZ LAKE SURFACE WATER QUALITY MONITORING PLAN

BW GOLD LTD
a subsidiary company of Artemis Gold Inc

Blackwater Gold Project

EAC #M19-01 Condition 28: Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan

March 2022

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ACRONYMS AND ABBREVIATIONS

Aboriginal Groups or Indigenous nations	Aboriginal Groups include: Lhoosk'uz Dené Nation, Ulkatcho First Nation, Nadleh Whut'en First Nation, Stellat'en First Nation, Saik'uz First Nation and Nazko First Nation (as defined in the Project's Environmental Assessment Certificate #M19-01)
AEMP	Aquatic Effects Monitoring Plan
BACI	Before-after-control-impact
BC	British Columbia
BC MOE	BC Ministry of Environment
Project, the	Blackwater Gold Project
BW Gold	BW Gold LTD.
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CSFNs	Carrier Sekani First Nations
DOC	Dissolved organic carbon
DS	Decision Statement
EAC	Environmental Assessment Certificate
ECCC	Environment and Climate Change Canada
EMC	Environmental Monitoring Committee
EMLI	Ministry of Energy, Mines and Low Carbon Innovation
ENV	BC Ministry of Environment and Climate Change Strategy
FWR	Freshwater Reservoir
km	Kilometre
m	Metre
MDL	Method detection limit
MDMER	*Metal and Diamond Mining Effluent Regulations*
µS/cm	Microsiemens per centimetre
mg/mL	Milligrams per millilitre
Mt	Million tonnes
Mtpa	Million tonnes per annum
MWLAP	Ministry of Water, Land and Air Protection
NTU	Nephelometric turbidity unit
POC	Parameter of concern
POPC	Parameter of potential concern

QA/QC	Quality Assurance and Quality Control
ROC	Receptor of concern
SBEB	Science Based Environmental Benchmark
SCP	Sediment Control Pond
t	Tonne
TDS	Total dissolved solids
tpd	Tonnes per day
TOC	Total organic carbon
TSF	Tailings Storage Facility
TSS	Total suspended solids
WMP	Water management pond
WQG-AL	Water quality guideline for the protection of aquatic life
WTP	Water treatment plant
YDWL	Yinka Dene Water Law

1. INTRODUCTION

The Blackwater Gold Project (the Project) is located approximately 112 kilometres (km) southwest of Vanderhoof, 160 km southwest of Prince George, and 446 km northeast of Vancouver, British Columbia (BC). The mine site is centered at latitude 53°11'22.872" N, and longitude 124°52'0.437" W (375400 E, 5893000 N) on National Topographic System sheet 93F/02.

The Project is a greenfield gold and silver open-pit mine with associated ore processing facilities. Project construction is anticipated to take two years. Mine operations will be phased with an initial milling capacity of 15,000 t/d or 5.5 million tones per annum (Mtpa) for the first five years of operation. After the first five years, the milling capacity will increase to 33,000 t/d (or 12 Mtpa) for the next five-years, and to 55,000 t/d (20 Mtpa) in Year +11 until the end of the 23-year mine life. The Closure phase is 24 to approximately 45 years, ending when the Open Pit has filled and the TSF is allowed to passively discharge to Davidson Creek, and the Post-closure phase is 46+ years. Ore will be processed in a plant by a combined gravity circuit and whole ore cyanide leach to recover gold and silver. The gold and silver will be recovered into a gold-silver doré product.

Surface water and groundwater discharges from the Project to the aquatic receiving environment are required through all phases (Construction, Operations, Closure, and Post-Closure) to maintain the site water balance requirements (see Appendix 9-E, Mine Site Water and Discharge Monitoring and Management Plan). Water will be discharged to Davidson Creek and Creek 661 in a manner that minimizes the potential for adverse effects to downstream receptors (flow and water quality). Thus, aquatic receiving environment monitoring programs have been developed to confirm adverse effects are not observed to either water flow or water quality in Davidson Creek and Creek 661 and downstream waters Tatelkuz Lake and Chedakuz Creek.

1.1 Purpose and Objective

The Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan (the Plan) has been developed in accordance with Environmental Assessment Certificate (EAC) #M19-01 Condition 28. Surface water quality monitoring and reporting to be conducted under the Plan will coincide with the Aquatic Effects Monitoring Program (AEMP) Plan developed as part of the Project's Joint *Mines Act*/*Environmental Management Act* Permits Application (the Application).

The purpose of the Plan is to detail Chedakuz Creek and Tatelkuz Lake surface water quality monitoring to achieve the following objectives:

- Detect Project-related effects on Tatelkuz Lake and Chedakuz Creek upstream of Nechako Reservoir surface water quality; and
- Confirm water quality predictions and effects assessments, as presented in Chapter 5 of the Application (Modelling, Mitigation, and Discharges) and Chapter 6 of the Application (Environmental Assessment Predictions), respectively.

An update to the Plan will be issued and appended to or incorporated into the AEMP Plan Version 1.0 following review, engagement, and consultation with Indigenous nations and regulators. The AEMP Plan Version 1.0 will include the appended first, final version of the Plan with subsequent Versions (e.g., Version 2.0, Version 3.0, etc.) issued when revisions to the Plan are needed to reflect updates or adjustments to the AEMP and the Plan over time.

1.2 Environmental Assessment Certificate

The Project received an EAC #M19-01 on June 21, 2019 under the 2002 *Environmental Assessment Act* approving the Project with conditions. The Plan has been developed to address EAC Condition 28, which requires the development of a Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan.

Table 1.2-1 indicates the concordance of the Plan with the EAC Condition 28 requirements.

Table 1.2-1: Concordance with Environmental Assessment #M19-01 Condition 28

Condition	Section of the Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan
The plan must include at least the following:	
a) Monitoring locations;	Section 3.1
b) Frequency of monitoring;	Section 3.2
c) The means by which the baseline information in Condition 27, Water Quality Report, and any other appropriate information or criteria as determined by a Qualified Professional, will be used to determine if there are adverse effects due to the Project to: d) Tatelkuz Lake; and e) Chedakuz Creek upstream of Nechako Reservoir;	Section 2.0
f) How the Holder has considered YDWL, other Aboriginal policies made available to the Holder from Aboriginal Groups, and ENV guidance in development of the criteria in paragraph c);	Section 3.5 (BW Gold has been collaborating with the Carrier Sekani First Nations (CSFNs) in regards to implementation of the YDWL and discussions with the CSFNs are ongoing.)
g) Conditions, if any, under which monitoring would no longer be required; and	Section 4 (Monitoring is no longer required when surface water and groundwater is no longer discharged to the aquatic receiving environment)
h) The means by which the Holder will communicate this information to Aboriginal Groups, including identification of the type of information to be provided, the frequency of reporting and the implications of the water quality observed at Chedakuz Creek for the Nechako Reservoir. Reports must include a summary written for a lay audience.	Section 4

1.3 Yinka Dene Water Law

The Plan takes into consideration the Yinka Dene Water Law (YDWL) as required by EAC Condition 28 and is described in the following documents:

- Yinka Dene ‘Uza’hné Surface Water Management Policy (Nadleh Whut’en and Stellat’en 2016a); and
- Yinka Dene ‘Uza’hné Guide to Surface Water Quality Standards (Nadleh Whut’en and Stellat’en 2016b).

BW Gold has been collaborating with the Carrier Sekani First Nations (CSFN) in regards to implementation of the YDWL and discussions are ongoing. The YDWL describes a system that classifies waters into three categories based on their cultural and ecological significance, including:

- High Cultural or Ecological Significance (Class I Waters);

- Sensitive Waters (Class II Waters); and
- Typical Waters (Class III Waters).

Baseline characterization requirements for implementation of the Yinka Dene ‘Uza’hné Surface Water Management Policy (Nadleh Whut’en and Stellat’en 2016a) including sampling frequency recommendations provided by CSFN representatives is expected to be completed at potential attainment sites by the end of 2022 (Appendix 2-K, 2011 to 2020 Baseline Water Quality Report).

2. EXISTING CONDITIONS AND WATER QUALITY PREDICTIONS

Surface water quality baseline data has been collected in Chedakuz Creek (at a location where Chedakuz Creek is expected to be affected by mine effluent discharge into Davidson Creek) and from Tatelkuz Lake. Spatial and temporal background (baseline) water quality observations are detailed in Appendix 2-K (2011 to 2020 Baseline Water Quality Report). The baseline observations and water quality model predictions summarized below will be used for analysis of Project related effects described in Section 3.5.

2.1 Chedakuz Creek Existing Conditions

Chedakuz Creek is a third to fourth order stream that originates above Kuyakuz Lake and flows approximately northwest to the Nechako Reservoir. Upper Chedakuz Creek is approximately 15 km long and flows into Kuyakuz Lake. Middle Chedakuz Creek is approximately 12 km long and flows between Kuyakuz and Tatelkuz lakes. Downstream of Tatelkuz Lake, Lower Chedakuz Creek flows northwest to the Nechako Reservoir for approximately 53 km. Chedakuz Creek is classified as a Class II waterbody for the purposes of the YDWL.

Baseline surface water quality sampling has been conducted at five locations within Lower Chedakuz upstream of the Nechako Reservoir (and downstream of Tatelkuz Lake; WQ8, WQ9, WQ-13, WQ29, and WQ 30; Table 2.1-1).

Water quality results indicated Chedakuz Creek is near-neutral to slightly alkaline with year-round low sensitivity to acid inputs. Alkalinity was seasonally variable and was generally inversely related to streamflows; the lowest mean alkalinity values were measured during freshet in May and June. Monthly mean stream hardness was soft (< 60 mg/L as CaCO3) and moderately hard (61 to 120 mg/L as $CaCO_3$). Total dissolved solids (TDS) followed a similar monthly variability as hardness and alkalinity with a reduction in TDS values during freshet (snowmelt) and other high flow periods (rainfall) as a result of dilution of surface waters. Total suspended solids and turbidity were generally low with peaks in suspended material observed in October and November 2017 likely related to fall rainfall events. Elevated mean monthly total suspended solids (TSS) concentrations and turbidity values during other months were typically the result of one sample weighting the average value and likely the result of sample contamination by sediment.

Total nitrogen was predominantly in its organic form as represented by Total Kjeldahl Nitrogen, although in some samples nitrate was the dominant species. All nitrogen species were below water quality guideline for the protection of aquatic life (WQG-AL). Phosphorus concentrations were generally in the oligotrophic to mesotrophic range of values. Phosphorus concentrations varied intra-annually, and were typically highest in April and May. Organic carbon concentrations were high and was predominantly observed as dissolved organic carbon (DOC). The highest concentrations of total organic carbon (TOC) and DOC were typically observed during freshet months (May and June). Higher concentrations of organic carbon were also observed during late summer/early fall (September and October). Total cyanide, thiocyanate, and Weak Acid Dissociable (WAD) cyanide concentrations at Chedakuz Creek stations tended to be below their detection limits. Chloride, fluoride, and sulphate concentrations tended to be low and less than federal and BC WQG-AL.

Guideline exceedances were observed in Chedakuz Creek for 11 total and dissolved metals: total and dissolved aluminum, total and dissolved cadmium, total and dissolved copper, dissolved iron, total mercury, total silver, and total and dissolved zinc (see Appendix 2-K, 2011 to 2020 Baseline Water Quality Report). Total and dissolved cadmium and total mercury exceedances were observed once each at WQ13; the instance of elevated total mercury in late May 2013 was consistent with observations in other Project streams.

The most frequently observed guideline exceedance in Chedakuz Creek was for total aluminum. Infrequent guideline exceedances for total zinc were also observed, and can be attributed to elevated zinc concentrations in lower Davidson and Turtle creeks.

Table 2.1-1: Baseline and Proposed Tatelkuz Lake and Chedakuz Creek Surface Water Quality Sampling Sites

Watershed	Site ID		GPS Coordinates		Rationale	Sampling History
	Baseline	Monitoring	Easting	Northing		
Tatelkuz Lake	WQ21	TL-01	387247	5905786	Deepest location at center of Tatlekuz Lake. Source of make-up water for Davidson Creek. Receive seepage from TSF spillway.	2012 to 2014
	-	TL-02	389674	5902558	Littoral zone sampling location. Potential TSF groundwater flow path to Tatelkuz Lake	New in 2022*
	-	TL-03	387455	5905132	Littoral zone sampling location. Potential TSF groundwater flow path to Tatelkuz Lake.	New in 2022*
	-	TL-04	385297	5906826	Littoral zone sampling location. Potential TSF groundwater flow path to Tatelkuz Lake.	New in 2022*
Chedakuz Creek	-	CC-05	390399	5901047	Mid-field impact site in lower Chedakuz Creek, near the inlet to Tatelkuz Lake. Potential receiving environment for seepage for pit lake and TSF.	New in 2021
	WQ8	CC-10	385401	5907627	Tatelkuz Lake outlet, inlet to Chedakuz Creek, potential receiving environment for seepage from pit lake and TSF. Upstream of confluence with Davidson Creek.	2011 - 2014, 2017 - 2020
	WQ9	CC-15	383937	5909423	Mid-field monitoring site on Chedakuz Creek, downstream of Davidson Creek confluence. This site would be expected to be affected by mine effluent discharge into Davidson Creek and seepage from pit lake and TSF.	2011 - 2014, 2016 - 2020
	WQ13	CC-20	383097	5910077	Far-field monitoring site on Chedakuz Creek, downstream of Turtle Creek confluence. This site would be expected to be affected by mine effluent discharge into Davidson Creek and seepage from pit lake and TSF.	2011 - 2013, 2017 - 2020
	WQ29	CC-30	375187	5916462	Far-field monitoring site on Chedakuz Creek, downstream of private properties. Established in 2019 in consultation with CSFNs as a potential site to meet EAC Condition 27 where no further effects on water quality from the project are predicted.	2019 - 2020
	WQ30	CC-40	368695	5918685	Far-field monitoring site on Chedakuz Creek, upstream of confluence with Nechako Reservoir. Established in 2019 in consultation with CSFNs as a potential site to meet EAC Condition 27 where no further effects on water quality from the project are predicted.	2019 - 2020

** Baseline water quality sampling will be collected in 2022, 2023, and 2024.*

2.2 Tatelkuz Lake Existing Conditions

Tatelkuz Lake is the second largest lake near the headwaters of Chedakuz Creek. It has a surface area of 927 hectares, a volume of 188 million cubic metres, and a mean depth of 20 metres (m). Tatelkuz Lake has six inlets and one outlet. The lake is categorized by exposed cobble and sandy beaches, and by a forested shoreline and supports a several species of fish (10 species of fish were observed or captured during 2013 baseline studies). Tatelkuz Lake has been classified as a Class I waterbody for the purposes of the YDWL.

Baseline sampling of Tatelkuz Lake was completed in 2012 (June and September), 2013 (January and April), and 2014 (April, July, September) at one site (WQ21; Table 2.1-1). Sampling was completed at the surface, middle, and bottom of the water column (with the exception of July and September 2014 whereby samples were collected at the middle depth only). Lake depth profiles (temperature, pH, conductivity, specific conductivity, and dissolved oxygen) were collected at 1 m intervals during each sampling event.

Results of the Tatelkuz Lake baseline sampling indicated that the lake is near-neutral to slightly alkaline in pH and classified as a moderately hard lake. Total dissolved solids were typically higher during winter months (representing under-ice measurements) than when measured in summer and early fall. Total suspended solids and turbidity were typically low exhibited minor seasonal variability. Concentrations of nutrients were generally low, except for occasional nitrate and phosphorus concentrations in samples from the lower layer of lakes, which may have been influenced by capture of lake bottom sediments. Nutrient concentrations did not exceed federal or BC WQG-AL. Phosphorus concentrations indicated conditions ranging from mesotrophic (0.01 to 0.02 mg/L) to meso eutrophic (0.02 to 0.035 mg/L), and exhibited minimal variability with depth. The majority of total organic carbon was in the dissolved phase as dissolved organic carbon. Total and WAD cyanide concentrations in Tatelkuz Lake were below the analytical detection limit (0.005 mg/L) in all samples collected. Chloride, fluoride, and sulphate concentrations tended to be low and less than federal and BC WQG-AL.

Overall, metal concentrations were low in Tatelkuz Lake with exceedance of the federal or BC WQG-AL in January 2013 samples only:

- Cadmium exceeded the CCME long-term WQG-AL by a factor of 1.01 in the bottom lake sample;
- Lead exceeded the CCME long-term WQG-AL by a factor of 1.49 in the bottom lake sample; and
- Zinc exceeded the BC WQG-AL by a factor of 2.71 in the bottom lake sample and by a factor of 1.59 in the middle lake sample.

2.3 Water Quality Predictions

Water quality predictions were not completed for Tatelkuz Lake however the node WQ8 at the outlet Tatelkuz Lake in Chedakuz Creek can be considered to be representative of Tatelkuz Lake water quality (Appendix 5-D, Surface Water Quality Model Technical Report). Assessment nodes were also at Chedakuz Creek baseline surface water quality monitoring stations WQ9 and WQ13.

Model predictions were screened against BC or federal WQG-AL to identify parameters of potential concern (POPCs) for aquatic life: nitrite; fluoride; total and dissolved aluminum; total and dissolved cadmium; total chromium; total iron; and total zinc. A parameter of concern (POC) was then identified from the POPC list as a parameter that had, as a result of the Project, a predicted concentration higher than an applicable water quality guideline for a receptor of concern and higher than the range of existing concentrations. Dissolved aluminum was identified as a POC because predicted concentrations were higher than the WQG-AL and were higher than the range of existing concentrations at one modelling node (WQ9 in Chedakuz Creek) during one month of Construction phase. High concentrations of aluminum can result in mortality and changes in growth or reproduction of aquatic biota. However, given that the predicted concentrations of dissolved aluminum are within the range of background concentrations to which resident aquatic biota have adapted, Project-related effects to aquatic biota were not predicted to occur.

Nitrogen forms (nitrate, nitrite, and ammonia) and total phosphorus were identified as "special case" POCs to be assessed in Chapter 6 (Effects Assessment Predictions) for aquatic resources, because changes in concentrations of these parameters, even at levels lower than the WQG-AL, can cause nutrient enrichment or eutrophication; this, in turn, can cause changes in primary producer abundance or community structure.

Although there is no WQG-AL, total dissolved solids (TDS) was also carried forward as a special case POC, based on interest expressed by ENV and best professional judgement. High TDS concentrations can cause osmoregulatory stress in aquatic biota which can affect biota abundance or community structure through impacts on growth, reproduction, or survival.

3. DESIGN OF SURFACE WATER QUALITY MONITORING

3.1 Monitoring Locations

3.1.1 Chedakuz Creek

The Creek 661, Davidson Creek, and Turtle Creek watersheds, with associated mining infrastructure, are all contained within the Chedakuz Creek watershed.

Surface water quality monitoring of Lower Chedakuz Creek (downstream of Davidson Creek) and Middle Chedakuz Creek will utilize the AEMP sampling sites and will be completed at six locations: CC-05, CC-10, CC-15, CC-20, CC-30, and CC-40 (Table 2.1-1 and Figure 3.1-1).

3.1.2 Tatelkuz Lake

Tatelkuz Lake is located downstream of Creek 661 which will receive discharge from a SCP during Construction phase and seepage from the TSF in Operations (and Closure and Post-closure). During operations, Tatelkuz Lake will be the source of make-up water for Davidson Creek instream flow needs via discharge from the FWR. In accordance with EAC Condition 31, a Tatelkuz Lake Protection Plan will be developed to address effects to Chedakuz Creek and Tatelkuz Lake fish habitat and lake ice conditions associated with drawdown of Tatelkuz Lake. Therefore, this Plan will focus on changes in water quality as a result of the Project discharges and seepage.

Surface water quality monitoring of Tatelkuz Lake for the purpose of this Plan will utilize the AEMP sampling site and will be conducted at TL-01 (Table 2.1-1 and Figure 3.1-1).

Groundwater flow from Davidson Creek and Creek 661 watersheds flows towards Tatelkuz Lake. A groundwater water quality monitoring program is planned to assess the effect of mine activities on groundwater quality during construction and operations (see Appendix 9-E, Mine Site Water and Discharge Monitoring and Management Plan). Monitoring wells will be used to assess the potential effects of seepage from the TSF that may bypass seepage collection measures and evaluate seepage flow paths and depths downgradient of the TSF and the Closure Spillway in the Creek 661 catchment. Thus, if groundwater quality is found to be influenced by mine activities, littoral zones in Tatelkuz Lake will be sampled the following year to assess potential effects specific to mine water seepage in Tatelkuz Lake (e.g., if the 2025 Groundwater Monitoring Program report determines a mine related effect at groundwater monitoring wells downstream of the TSF, littoral zones will be sampled beginning in the open water season of 2026). Three littoral sites have been selected for sampling where potential groundwater flow paths may occur (see Figure 3-8, Appendix 5-F, Numerical Groundwater Modelling Report) along the western perimeter of Tatelkuz Lake where seepage flow paths may exist (TL-02, TL-03, and TL-04; Table 2.1-1 and Figure 3.1-1). Seepage travel times are anticipated to be at minimum 5 to 6 years after construction thus baseline information at the littoral sites can be collected in years 2022, 2023, and 2024.

3.2 Sample Timing, Frequency, and Replication

Monthly, quarterly, or weekly sampling of Chedakuz Creek sites will be conducted as per the AEMP sampling program (see Table 4.2-2 of the AEMP Plan).

Quarterly sampling of Tatelkuz Lake (TL-01) water quality will be completed to capture variability during both the ice-covered season (November and February) and open-water season (May and August). Lake sampling will be conducted at three depths within water column (surface, middle, and bottom) with 10% duplication at each sampling event (coinciding with the AEMP sampling program and the Tatelkuz Lake Protection Plan; see Table 4.2-2 of the AEMP Plan). Monthly sampling of Tatelkuz Lake littoral zone sites (TL-02, TL-03, and TL-04) will be completed when/if initiated. Under-ice sampling at littoral zone sites may be limited to months where access is safe for sample collection. Baseline water quality samples will be collected for the first time at the littoral sites in 2022, therefore timing of sampling may be adjusted as well as adjustments to location to avoid sampling water influenced by sediment in shallow areas.

3.3 Measurement and Assessment Endpoints

Surface water chemistry will be evaluated with one or more assessment endpoints including comparison to water quality guidelines for the protection of freshwater aquatic life (WQG-AL; BC ENV 2019a, 2021, CCME 2021a), the YDWL water quality standards, background (baseline) or reference ranges, and/or before-after-control-impact (BACI) analysis (Table 3.3-1).

Table 3.3-1: Measurement and Assessment Endpoints for Surface Water Quality

Measurement Endpoint	Assessment Endpoint
Surface water chemistry	Comparison to BC or CCME WQG (BC 2019a, 2021; CCME 2021a) or Yinka Dene Water Law water quality standards Comparison to background or reference ranges[1] Before-after-control-impact (BACI) analysis[2]

Notes:

[1] For in situ water quality parameters: temperature, pH, conductivity, turbidity, and dissolved oxygen.

[2] For water quality parameters analyzed at the laboratory: total suspended solids, pH, alkalinity, radium-226, total phosphorus, ammonia-N, nitrate-N, nitrite-N, chloride, fluoride, sulphate, cyanide (total and WAD), total metals including aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, and zinc; dissolved metals including aluminum, cadmium, calcium, copper iron, manganese, and zinc.

3.4 Sampling Methods

3.4.1 Field Methods

In situ profiles of dissolved oxygen, pH, conductivity, specific conductivity, and temperature at approximately 1 m intervals will be completed at each lake sampling event and at each stream site. When the lake is thermally stratified (indicated by the water column profile) sampling depths will include above and below the thermocline. In situ measurements will be taken using a calibrated multi-parameter meter (e.g., YSI Professional Plus).

For lake chemistry samples, discrete samples will be collected at three depths (shallow, middle, and bottom) in the water column during the open-water season using an acid washed Van Dorn water sampler or similar (e.g., Kemmerer).

All samples will be collected for the parameters outlined in Table 4.4-3 of the AEMP Plan (Appendix 7-A) and field filtered and/or preserved in the field according to the analytical laboratories protocols. Samples will be stored in coolers on ice and/or refrigerated until shipped to an accredited analytical laboratory for sample analysis.

3.4.2 Laboratory Methods

Water quality samples will be collected for analysis of general physical/ion parameters, nutrients and organics, cyanide, and total and dissolved metals at a Canadian Association for Laboratory Accreditation (CALA) laboratory. The water quality parameters to be analysed (see Table 4.4-3 of the AEMP Plan) will be completed using standard practices. Targeted detection limits for parameters will be at least 10 times lower than water quality guidelines or standards, where available, consistent with recommendations for other environmental media in BC ENV (2016).

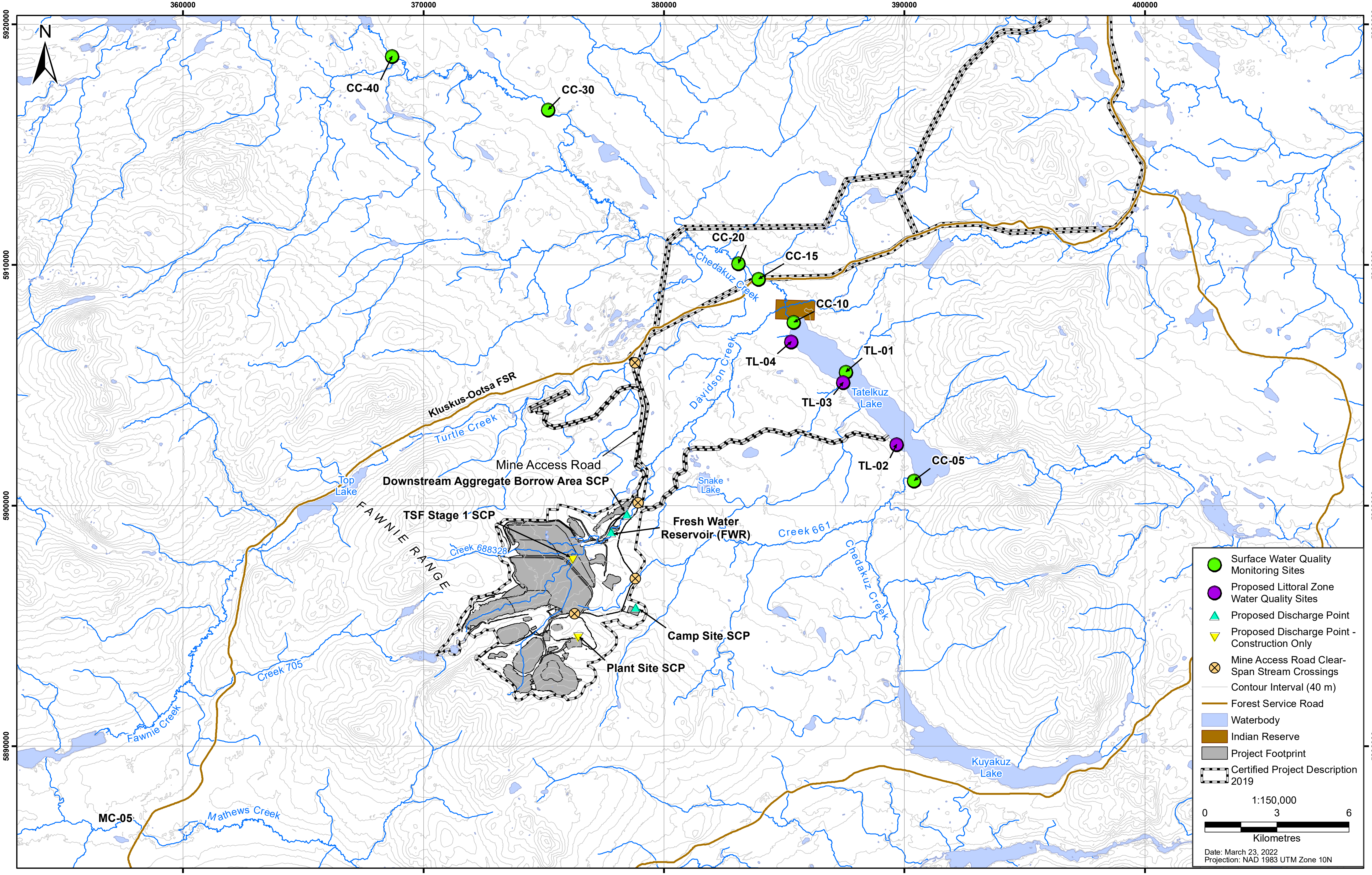

Figure 3.1-1: Chedakuz Creek and Tatelkuz Lake Surface Water Quality Sampling Locations

3.4.3 Quality Assurance and Quality Control

Quality assurance and quality control principles and procedures will follow those detailed in Section 4.4.2.2 of the AEMP Plan.

3.5 Data Analysis

For analysis and graphing purposes, parameter concentrations below the MDL will be assigned a concentration of half the reported MDL. Field duplicates will be treated as one sample represented by the average concentration of the replicate samples. Weekly samples collected in one month (from 5-in-30 sampling) will be treated as one sample as a monthly mean concentration.

Potential effects of temperature, field pH, conductivity, turbidity, and dissolved oxygen will be assessed by graphical analysis for comparison to baseline and/or reference ranges (Table 3.3-1). Reference ranges will be defined as the 5th to 95th percentile concentrations from the baseline (background) or reference dataset. Since baseline data collection is ongoing for surface water quality, background and/or reference ranges will be based on data collected prior to Project construction and data collected at reference sites. Data collected at AEMP reference sites will be made available for comparison and analysis of surface water quality changes in Tatelkuz Lake and Chedakuz Creek.

Data analysis and reporting will focus on the POPCs and POCs for the Project. Nitrite, fluoride, sulfate, total and dissolved aluminum, total cadmium, total chromium, total iron, and total zinc were identified as the POPCs in the CSM because their baseline or predicted concentrations were higher than 80% of the WQG-AL (Appendix 7-B). Nitrogen forms (nitrate, nitrite, ammonia), total phosphorus, and TDS were the water quality parameters identified as the Project-related special-case POCs for aquatic life in the CSM and dissolved aluminum was identified as a POC (Appendix 7-B). The CSM also recommended the inclusion of total mercury in monitoring due to uncertainties in the geochemical source terms used in water quality predictions (Appendix 7-B). The list of evaluated parameters may be modified as part of the AEMP reporting to include other parameters if concentrations increase or are predicted to increase.

In addition to the POPCs and POCs, analysis of water chemistry will include constituents with available BC WQG-AL (ENV 2019a, 2021), federal WQG-AL (CCME 2021a), approved SBEBs, or YDWL water quality standards (Table 3.3-1). A dissolved aluminum SBEB has been proposed for Davidson Creek and Creek 661 that is based on the background method (i.e., the SBEB is based on the seasonal 95th percentile + 20% of concentrations measured in Davidson Creek and Creek 661 prior to development of the Project; Lorax 2022). No Project-related effects to aquatic biota would be expected if the future concentrations of dissolved aluminum remain below the SBEB. Once approved, the dissolved aluminum SBEB would be used as the applicable benchmark in place of the BC WQG-AL.

To assess Project-related effects on surface water quality in Tatelkuz Lake and Chedakuz Creek a BACI analysis will be completed as defined in Section 4.4.2.3 of the AEMP Plan. The list of evaluated parameters may be modified as part of the Plan reporting to include other parameters if concentrations increase or are predicted to increase. To assess Project-related effects on surface water quality at the Tatelkuz Lake littoral zones, a before-after analysis will be completed similar to the BACI, with classification of the sites as either ‘before’ or ‘after’ exposure.

Observations of groundwater quality at monitoring wells that assess the groundwater flow paths that potentially enter Tatelkuz Lake will be used to aid in the interpretation of water quality observations in Tatelkuz Lake including littoral zone sites if sampled.

4. IMPLEMENTATION AND REPORTING

Sampling conducted in accordance with this Plan will be initiated beginning in Construction and continue while point source discharge to the receiving environment occurs. A qualified professional may determine that sufficient sampling has been completed under the Plan and recommend the termination of selected or all long-term monitoring through the Closure and Post-closure phases. The recommendation to terminate water quality monitoring under this Plan must be supported by rationale either in a stand-alone report or in the annual reporting required by this Plan. Rationale provided could include some or all of the following:

- The Project has been successfully decommissioned and monitoring under the Closure and Reclamation Plan confirms that reclamation has been successful and continued monitoring of the aquatic receiving environment is not warranted.
- Statistically significant changes in water quality have not occurred in preceding Project phases and after a predetermined number of years once the Project is in Post-closure phase. The number of Post-closure monitoring years will be determined by a qualified professional once water quality models have been updated with operational data.
- Data (e.g., monitoring or predictive modelling) suggests that sources including groundwater and/or transport pathways of POCs from the Project are either decreasing or have stabilized and are unlikely to change significantly in the future.
- Monitoring for predetermined number of years once the Project is in Post-closure phase shows that measured concentrations are below applicable guidelines, standards or benchmarks. The number of Post-closure monitoring years will be determined by a qualified professional once water quality models have been updated with operational data.
- Any other rationale that the qualified professional identifies to warrant a recommendation to significantly decrease the frequency or terminate the Plan monitoring.

Condition 5 of the EAC sets out timelines for reporting requirements. BW Gold must submit a report to the attention of the EAO and Aboriginal Groups on the status of compliance with EAC #M19-01 at the following times:

1. *at least 30 days prior to the start of Construction;*
2. *on or before March 31 in each year after the start of Construction;*
3. *at least 30 days prior to the start of Operations;*
4. *on or before March 31 in each year after the start of Operations;*
5. *at least 30 days prior to the start of Closure;*
6. *on or before March 31 in each year after the start of Closure until the end of Closure;*
7. *at least 30 days prior to the start of Post-Closure; and*
8. *on or before March 31 in each year after the start of Post-Closure until the end of Post-Closure.*

BW Gold will submit reports to the EAO and Aboriginal Groups within the timelines specified in Condition 5.

A Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring report will be generated for each year in which data are collected under the Plan and will be incorporated into the annual AEMP report and include:

- A summary written for a lay audience;

- A statistical summary (i.e., mean, and standard error) of surface water data collected at Chedakuz Creek and Tatelkuz Lake within a given calendar year (analytical results will be referenced and provided in the AEMP report);
- An analysis of Project related effects on Chedakuz Creek and Tatelkuz Lake;
- A discussion of implications of water quality observed at Chedakuz Creek for Nechako Reservoir if Project related effects are observed; and
- Evaluate the effectiveness of the Plan and ensure that the objectives defined in Section 1.1 are being met.

The report will be completed for submission to Indigenous nations, the Environmental Monitoring Committee (EMC), regulators including ENV, EAO, BC Ministry of Energy, Mines, and Low-carbon Initiatives, and BC Ministry of Forests, Lands, Natural Resource Operations & Rural Development by March 31 of the following year.

Changes or improvements to the sampling can be implemented between annual review cycles, with agreement of Indigenous nations. This may include updates to the sampling plan to address potential effects related to emergencies and/or temporary shutdowns. The annual AEMP report will include any recommendations for changes to the scope or timing of the AEMP sampling, including rationale for any recommended changes.

5. REFERENCES

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ATTACHMENT C CONCORDANCE WITH FEDERAL DECISION STATEMENT (APRIL 15, 2019)

Attachment C: Concordance of the Federal Decision Statement with Aquatic Effects Monitoring Program Plan

Federal Decision Statement Condition	Section in the Aquatic Effects Monitoring Program Plan
Fish and fish habitat	
3.8 The Proponent shall develop, prior to construction, measures to maintain instream flow needs in Davidson Creek. The Proponent shall maintain instream flow needs in Davidson Creek during all phases of the Designated Project at a minimum within flow rates recommended by the Proponent in Appendix 5.1.2.6D of the Environmental Impact Statement, unless otherwise authorized by Fisheries and Oceans Canada.	Section 4.3.1 (Surface Water Quantity Measurement and Assessment Endpoints) Section 5.0; triggers and action responses for fish habitat - hydrology are identified in Table 5-1 in Section 5.0 (Trigger Action Response Plan)
3.9 The Proponent shall maintain water temperature in Davidson Creek, as described by the Proponent in Section 5 of Appendix A (Blackwater Gold Project – Assessment of Flows from the Water Treatment Plant and North and South Diversions on Davidson Creek Temperatures. Knight Piesold. Memorandum VA16-01038) of Appendix C-1 of the Environmental Impact Statement Supplemental Report Assessment of Effects Related to Project Changes (August 2016), unless otherwise authorized by Fisheries and Oceans Canada.	Section 4.4.1.1 (Surface Water Temperature Measurement and Assessment Endpoints); triggers and action responses for fish habitat - temperature are identified in Table 5-2 in Section 5.0 (Trigger Action Response Plan)
3.14 The Proponent shall develop, prior to construction and in consultation with Indigenous groups, Fisheries and Oceans Canada, and other relevant authorities, a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the mitigation measures as it pertains to adverse environmental effects of the Designated Project on fish and fish habitat. The Proponent shall implement the follow-up program during all phases of the Designated Project and shall apply conditions 2.9 and 2.10 when implementing the follow-up program. As part of the follow-up program, the Proponent shall:	Follow-up program design to be completed prior to construction under a separate cover.
3.14.1 conduct parasite and pathogen inventories in Lake 01538UEUT and Lake 01682LNRS prior to enlarging Lake 01682LNRS and connecting it to Lake 01538UEUT pursuant to condition 3.13 and compare the results of the parasite and pathogen inventories for the two lakes;	
3.14.2 monitor, starting when the Proponent starts to pump water into Davidson Creek and continuing through until the freshwater supply system has been decommissioned, rainbow trout (*Oncorhynchus mykiss*) and Kokanee (*Oncorhynchus nerka*) populations in Davidson Creek, including:	
3.14.2.1 community composition of rainbow trout (*Oncorhynchus mykiss*) and Kokanee (*Oncorhynchus nerka*), their absolute abundance, genetic structure and diversity;	
3.14.2.2 absolute abundance of overwintering rainbow trout juveniles; and	
3.14.2.3 characteristics of spawner populations through surrogate monitoring metrics including size at 50% maturity, redd counts and spawner distribution.	

Federal Decision Statement Condition	Section in the Aquatic Effects Monitoring Program Plan
3.15 The Proponent shall develop, in consultation with Indigenous groups and other relevant authorities, a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the mitigation measures as it pertains to adverse environmental effects of the Designated Project on fish habitat in Davidson Creek, Creek 661 and Chedakuz Creek. The Proponent shall develop the follow-up program prior to construction and shall implement the follow-up program during all phases of the Designated Project. The Proponent shall apply conditions 2.9 and 2.10 when implementing the follow-up program. As part of the follow-up program, the Proponent shall:	Section 1.1 (Purpose and Objectives)
3.15.1 monitor water flows in Davidson Creek during the open water season from construction until decommissioning, and temperature continuously from construction until decommissioning;	Water flow monitoring for major catchments including Davidson Creek catchment is described in 4.3 (Hydrology (Surface Water Quantity) and triggers and action responses for fish habitat - hydrology are identified in Table 5-1 in Section 5 (Trigger Action Response Plan)
3.15.2 monitor water quality in Davidson Creek, Creek 661 and Chedakuz Creek for contaminants of potential concern, including those identified in Table 5 of the environmental assessment report, during all phases of the Designated Project; and	Surface water quality monitoring is described in Section 4.4.2 (Surface Water Quality Sampling)
3.15.3 monitor, during all phases of the Designated Project, groundwater quality and quantity downstream of the tailings storage facility site D, open pit, west waste rock dump and low-grade ore stockpile to confirm that groundwater quantity and quality parameters are at or below the values identified by the Proponent in the modelled predictions in Section 5 of Blackwater Gold Project: Additional Water Quality Model Sensitivity Scenario (July 20, 2017) and Section 3 of Blackwater Gold Project: Water Treatment Responses for Comments 1266, 1270, 1271, 1272, and 1273 (February 15, 2017) for nitrite and contaminants of potential concern, and to verify the effectiveness of water management measures.	Mine site groundwater quality and flow monitoring is described in Section 7.3.4 (Mine Site Groundwater Quality and Flow) of the Mine Site Water and Discharge Monitoring and Management Plan. Adaptive management for groundwater is described in Section 11 (Table 11-1: Mine Site Water Adaptive Management Actions) and Section 11.1 (Groundwater Adaptive Management and Contingency Actions) of the Mine Site Water and Discharge Monitoring and Management Plan.

Federal Decision Statement Condition	Section in the Aquatic Effects Monitoring Program Plan
3.16 The Proponent shall develop, prior to construction and in consultation with Indigenous groups and relevant authorities, a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the mitigation measures as it pertains to fish habitat in Tatelkuz Lake and Chedakuz Creek. The Proponent shall implement the follow-up program from construction through decommissioning and shall apply conditions 2.9 and 2.10 when implementing the follow-up program. As part of the follow-up program, the Proponent shall:	Follow-up program design to be completed prior to construction under a separate cover.
3.16.1 conduct, prior to the commissioning of the freshwater supply system, fish habitat quantity and quality surveys in the Tatelkuz Lake littoral zone;	
3.16.2 monitor the Tatelkuz Lake littoral zone from the commissioning of the freshwater supply system until decommissioning; and	
3.16.3 monitor water flows in Chedakuz Creek between Tatelkuz Lake and the confluence with Davidson Creek during the open water season from construction until decommissioning.	Section 4.3
Consultation	
2.3 The Proponent shall, where consultation is a requirement of a condition set out in this Decision Statement:	Referenced in Section 2.3 for future engagement and consultation
2.3.1 provide a written notice of the opportunity for the party or parties being consulted to present their views and information on the subject of the consultation;	
2.3.2 provide all information available and relevant on the scope and the subject matter of the consultation and a period of time agreed upon with the party or parties being consulted, not less than 15 days, to prepare their views and information;	
2.3.3 undertake a full and impartial consideration of all views and information presented by the party or parties being consulted on the subject matter of the consultation;	
2.3.4 strive to reach consensus with Indigenous groups; and	
2.3.5 advise the party or parties being consulted on how the views and information received have been considered by the Proponent including a rationale for why the views have, or have not, been integrated. The Proponent shall advise the party or parties in a time period that does not exceed the period of time taken in 2.3.2.	
2.4 The Proponent shall, where consultation with Indigenous groups is a requirement of a condition set out in this Decision Statement, determine and strive to reach consensus with each Indigenous group regarding the manner by which to satisfy the consultation requirements referred to in condition 2.3, including:	Referenced in Section 2.3 for future engagement and consultation
2.4.1 the methods of notification;	
2.4.2 the type of information and the period of time to be provided when seeking input;	
2.4.3 the process to be used by the Proponent to undertake impartial consideration of all views and information presented on the subject of the consultation; and	

Federal Decision Statement Condition	Section in the Aquatic Effects Monitoring Program Plan
2.4.4 the period of time and the means by which to advise Indigenous groups of how their views and information were considered by the Proponent.	
Follow-up and adaptive management – Condition 3.15	
2.5 The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement, have a Qualified Professional, where such a qualification exists for the subject matter of the follow-up program, determine, as part of the development of each follow-up program and in consultation with the party or parties being consulted during the development, the following information:	Section 8
2.5.1 the follow-up activities that must be undertaken by a qualified individual;	Implementation of the AEMP will be undertaken by qualified individuals.
2.5.2 the methodology, location, frequency, timing and duration of monitoring associated with the follow-up program;	Sections 4.3, 4.4.1, and 4.4.2 provide methodology; Section 4.2 provides the locations, timing, and frequency of sampling [*see also Section 7.3.4 of the Mine Site Water and Discharge Monitoring and Management Plan*]
2.5.3 the scope, content, format and frequency of reporting of the results of the follow-up program;	Section 7.2 [*see also Section 12.1 of the Mine Site Water and Discharge Monitoring and Management Plan*]
2.5.4 the levels of environmental change relative to baseline conditions that would require the Proponent to implement modified or additional mitigation measure(s), including instances where the Proponent may require Designated Project activities to be stopped; and	Section 6.2 (tables 6.2-2, 6.2-3, 6.2-4, 6.2-5, 6.2-6) [*see also Table 11-1 and Section 11.1 of the Mine Site Water and Discharge Monitoring and Management Plan*]
2.5.5 the technically and economically feasible mitigation measures to be implemented by the Proponent if monitoring conducted as part of the follow-up program shows that the levels of environmental change referred to in condition 2.5.4 have been reached or exceeded.	Section 5 and Section 6.2 (tables 5-1, 5-3, 6.2-2, 6.2-3, 6.2-4, 6.2-5, 6.2-6) [*see also Table 11-1 and Section 11.1 of the Mine Site Water and Discharge Monitoring and Management Plan*]

Federal Decision Statement Condition	Section in the Aquatic Effects Monitoring Program Plan
2.6 The Proponent shall update and maintain the follow-up and adaptive management information referred to in condition 2.5 during the implementation of each follow-up program in consultation with the party or parties being consulted during the development of each follow-up program.	Section 2.3
2.7 The Proponent shall provide a draft of the follow-up programs referred to in conditions 3.14, 3.15, 3.16, 4.5, 5.5, 6.11, 6.12, 6.13, 6.14, 8.18.6, 8.20.5, 8.21, and 8.22, if required, to the party or parties being consulted during the development of each follow-up program for a consultation period of up to 60 days prior to providing follow-up programs pursuant to condition 2.8.	Section 2.3
2.8 The Proponent shall provide the follow-up programs referred to in conditions 3.14, 3.15, 3.16, 4.5, 5.5, 6.11, 6.12, 6.13, 6.14, 8.18.6, 8.20.5, 8.21, and 8.22, if required, to the Agency and to the party or parties being consulted during the development of each follow-up program prior to the implementation of each follow-up program. The Proponent shall also provide any update(s) made pursuant to condition 2.6 to the Agency and to the party or parties being consulted during the development of each follow-up program within 30 days of the follow-up program being updated.	Section 2.1 and Section 2.2
2.9 The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement:	
2.9.1 conduct the follow-up program according to the information determined pursuant to condition 2.5;	The AEMP will be conducted in accordance with the information determined pursuant to condition 2.5.
2.9.2 undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure(s);	Monitoring- sections 4.1, 4.2, 4.3 and 4.4 Analysis- sections 4.3.4, 4.4.2.3, and 4.4.3.3 [*see also sections 7.3.4.1 and 7.3.4.2. of the Mine Site Water and Discharge Monitoring and Management Plan*]
2.9.3 determine whether modified or additional mitigation measures are required based on the monitoring and analysis undertaken in accordance with condition 2.9.2; and	Sections 5 and 6.2.1 [*see also Table 11-1 and Section 11.1 of the Mine Site Water and Discharge Monitoring and Management Plan*]
2.9.4 if modified or additional mitigation measures are required pursuant to condition 2.9.3, develop and implement these mitigation measures in a timely manner and monitor them in accordance with condition 2.9.2.	Sections 5 and 6.2.1 [*see also Table 11-1 and Section 11.1 of the Mine Site Water and Discharge Monitoring and Management Plan*]

Federal Decision Statement Condition	Section in the Aquatic Effects Monitoring Program Plan
2.10 Where consultation with Indigenous groups is a requirement of a follow-up program, the Proponent shall discuss the follow-up program with Indigenous groups and determine, in consultation with Indigenous groups, opportunities for their participation in the implementation of the follow-up program, including the analysis of the follow-up results and whether modified or additional mitigation measures are required, as set out in condition 2.9.	Section 2.0 [*see also Section 5 and 11 of the Mine Site Water and Discharge Monitoring and Management Plan*]
Annual Reporting	
2.11 The Proponent shall, commencing in the reporting year during which the Proponent begins the implementation of the conditions set out in this Decision Statement, prepare an annual report that sets out:	Section 7.2
2.11.1 the activities undertaken by the Proponent in the reporting year to comply with each of the conditions set out in this Decision Statement;	
2.11.2 how the Proponent complied with condition 2.1;	
2.11.3 for conditions set out in this Decision Statement for which consultation is a requirement, how the Proponent considered any views and information that the Proponent received during or as a result of the consultation, including a rationale for how the views have, or have not, been integrated;	
2.11.4 the information referred to in conditions 2.5 and 2.6 for each follow-up program;	
2.11.5 the results of the follow-up program requirements identified in conditions 3.14, 3.15, 3.16, 4.5, 5.5, 6.11, 6.12, 6.13, 6.14, 8.18.6, 8.20.5, 8.21, and 8.22 if required;	
2.11.6 any update made to any follow-up program in the reporting year;	
2.11.7 any modified or additional mitigation measures implemented or proposed to be implemented by the Proponent, as determined under condition 2.9 and rationale for why mitigation measures were selected pursuant to condition 2.5.4; and	
2.11.8 any change(s) to the Designated Project in the reporting year.	
2.12 The Proponent shall provide a draft annual report referred to in condition 2.11 to Indigenous groups, no later than June 30 following the reporting year to which the annual report applies. The Proponent shall consult Indigenous groups on the content and findings in the draft annual report.	
2.13 The Proponent, in consideration of any comments received from Indigenous groups pursuant to condition, 2.12 shall revise and submit to the Agency and Indigenous groups a final annual report, including an executive summary in both official languages, no later than September 30 following the reporting year to which the annual report applies.	

ATTACHMENT D BASELINE AND PROPOSED WATER QUALITY AND AQUATIC RESOURCE SAMPLING LOCATIONS

Attachment D: Baseline and Proposed Water Quality and Aquatic Resource Sampling Locations

Watershed	Proposed Sampling Site Name	GPS Coordinates		2011 - 2020 Baseline Sampling Site Name[1]		
		Easting	Northing	Water Quality	Sediment Quality and Aquatic Resources[2] (2011-2012)	Sediment Quality and Aquatic Resources[2] (2017)
Streams						
Davidson Creek	DC-05	378205	5899299	WQ28	BI-02 (2011, 2012)	WQ28
	DC-10	378855	5900126	WQ27	no proposed sampling	
	DC-15	381880	5904065	WQ26	BI-01 (2011, 2012)	-[3]
	DC-20	384244	5907733	WQ7	no proposed sampling	
Turtle Creek	TC-01	369772	5902753	WQ19	-	-
	TC-05	374261	5903206	WQ11	BI-08 (2011, 2012)	-
	TC-10	378796	5906055	-[3]	BI-07 (2011, 2012)	-
	TC-15	383023	5908521	WQ14	no proposed sampling	
Creek 661	661-05	378894	5897037	WQ3	-	WQ3[3]
	661-10	381255	5897993	WQ5	BI-05 (2011, 2012)	WQ5
	661-20	388707	5899424	-[3]	no proposed sampling	
Chedakuz Creek	CC-03	388667	5899132	-[3]	no proposed sampling	
	CC-05	390399	5901047	-[3]	no proposed sampling	
	CC-10	385401	5907627	WQ8	no proposed sampling	
	CC-12	385080	5908171	no proposed sampling	no proposed sampling	
	CC-15	383937	5909423	WQ9	no proposed sampling	
	CC-20	383097	5910077	WQ13	no proposed sampling	
	CC-30	375187	5916462	WQ29	no proposed sampling	
	CC-40	368695	5918685	WQ30	no proposed sampling	
Creek 705	705-05	365740	5894247	WQ12	BI-12 (2012)	WQ12
	705-10	362275	5893055	BI-09	BI-09 (2011, 2012)	-
Fawnie Creek	FC-01	363830	5899354	BI-13	BI-13 (2012)	BI-13
Matthews Creek	MC-05	358247	5886498	BI-13	no proposed sampling	
Lakes						
Kuyakuz Lake	KL-01	395187	5888710	WQ20	no proposed sampling	
Tatelkuz Lake	TL-01	387247	5905786	WQ21	no proposed sampling	

Notes:

Dashes indicate sampling was not completed at the proposed Aquatic Effects Monitoring Program sampling location between 2011 and 2020.

[1] Baseline water quality years sampled and sampling frequency is provided in Appendix 2-K, 2011 to 2020 Baseline Water Quality Report..

[2] Aquatic resources include primary producer sampling (periphyton), and benthic invertebrate sampling.

[3] Baseline sampling was initiated in 2021 (new water quality sites) or additional aquatic resources data were collected in 2021.

ATTACHMENT E 2020 PROVINCIAL AND FEDERAL WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

Attachment E: 2020 Provincial and Federal Water Quality Guidelines for the Protection of Freshwater Aquatic Life

Parameter	BC Water Quality Guidelines[a]	CCME Guideline for the Protection of Freshwater Aquatic Life[b]
Physical Tests		
pH	6.5 to 9.0	6.5 to 9.0
Total Suspended Solids	Dependent on background levels[d]	Dependent on background levels[c]
Turbidity (NTU)	Dependent on background levels[f]	Dependent on background levels[e]
Anions		
Chloride (Cl)	600 maximum; 150 for 30-day period	640 short-term; 120 long-term
Fluoride (F)	Hardness-dependent[g]	0.12[h]
Sulphate (SO_4)	Hardness-dependent[i]	-
Nutrients		
Ammonia, Total (as N)	pH- and temperature-dependent	pH- and temperature-dependent
Nitrate (as N)	32.8 maximum; 3.0 for 30-day period	550 short-term; 13 long-term
Nitrite (as N)	Chloride-dependent[y]	0.06 long-term
Phosphorus (P)-Total	0.005 to 0.015 (lakes)	Trigger ranges[j]
Cyanides		
Cyanide, Weak Acid Diss.	0.01 maximum; 0.005 for 30-day period	-
Cyanide, Free	-	0.005
Organic Carbon (Total/Dissolved)	Dependent on background levels[k]	-
Total Metals		
Aluminum (Al)	-	0.005 if pH < 6.5; 0.1 if pH ≥ 6.5
Antimony (Sb)	0.009[l]	-
Arsenic (As)	0.005 30-day period	0.005 long-term
Barium (Ba)	1[l]	-
Beryllium (Be)	0.00013[l]	-
Boron (B)	1.2 30-day period	29 short-term; 1.5 long-term
Cadmium (Cd)	-	Hardness-dependent[m]
Chromium (Cr)	30-day: 0.001 (Cr[VI]), 0.0089 (Cr[III])	Long-term: 0.001 (Cr[VI]); 0.0089 (Cr[III])
Cobalt (Co)	0.11 maximum; 0.004 for 30-day period	-
Copper (Cu)	-	Hardness-dependent[o]
Iron (Fe)	1 maximum	0.3 long-term
Lead (Pb)	Hardness-dependent[p]	Hardness-dependent[q]
Manganese (Mn)	Hardness-dependent[r]	-
Mercury (Hg)	0.00002 when MeHg = 0.5% THg	0.000026
Molybdenum (Mo)	2 maximum; ≤1 for 30-day period	0.073[h]
Nickel (Ni)	Hardness-dependent[l,s]	Hardness-dependent[t]
Selenium (Se)	0.002	0.001
Silver (Ag)	Hardness-dependent[u]	0.00025 long-term
Thallium (Tl)	0.0008[l]	0.0008 long-term
Uranium (U)	0.0085[l]	0.033 short-term; 0.015 long-term
Zinc (Zn)	Hardness-dependent[v]	0.03 long-term
Dissolved Metals		
Aluminum (Al)	pH-dependent[w]	-
Cadmium (Cd)	Hardness-dependent[x]	
Copper (Cu)	Water chemistry-dependent[n]	
Iron (Fe)	0.35 maximum	-
Manganese (Mn)	-	pH- and hardness-dependent[aa]
Zinc (Zn)	-	pH-, Hardness-, DOC-dependent[z]

Notes:
All units are in mg/L unless otherwise noted.

[a] British Columbia Guidelines for the Protection of Freshwater Aquatic Life, approved (BC ENV 2016b) unless otherwise noted for a specific parameter.

[b] Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic life, Canadian Council of Ministers of the Environment (CCME 2020).

[c] Total Suspended Solids (TSS) - in clear flow, maximum increase of 25 mg/L from background levels for short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for long-term exposure. In high flow, maximum increase of 25 mg/L from background levels between 25-250 mg/L. If background is ≥ 250 mg/L, then it should not increase more than 10% of background levels.

[d] TSS - change from background for 24-h period is 25 mg/L and 5mg/L for 30-day period; if background is 25-100 mg/L then change from background of 10 mg/L; if background > 100 mg/L then change from background of 10%.

[e] Turbidity - in clear flow maximum increase of 8 NTUs from background levels for short-term exposure (e.g., 24 -h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period). In high flow maximum increase of 8 NTUs from background levels (8 to 80 NTUs); when background is > 80 NTUs, turbidity should not increase more than 10%.

[f] Turbidity - change from background for 24-h period is 8 NTU and 2 NTU for 30-day period; if background is 8-50 NTU then change from background is 5 NTU; if background > 50 NTU then change from background of 10%.

*[g] Fluoride - if hardness (as $CaCO_3$) is 10 mg/L the maximum concentration is 0.4 mg/L; otherwise LC_{50} = -51.73 + 92.57 $\log_{10}$ (hardness) * 0.01 mg/L.*

[h] Interim guideline.

[i] Sulphate – if hardness (as $CaCO_3$) is 0-30 mg/L the 30-day mean is 128 mg/L; if hardness 31-75 mg/L the 30-day mean is 218 mg/L; if hardness 76-180 mg/L the 30-day mean is 309 mg/L; if hardness 181-250 mg/L, the 30-day mean is 429 mg/L; if hardness >250 mg/L, site-specific guidelines apply.

[j] Phosphorus trigger ranges: < 0.004 mg/L ultra-oligotrophic; 0.004-0.01 mg/L oligotrophic; 0.01-0.02 mg/L mesotrophic; 0.02-0.035 mg/L meso-eutrophic; 0.035-0.1 mg/L eutrophic; > 0.1 mg/L hyper-eutrophic.

[k] Total organic carbon - the 30-day median ± 20% of the median background concentration.

[l] Working guideline.

[m] Cadmium – short-term: if hardness (as $CaCO_3$) is < 5.3 mg/L, cadmium benchmark is 0.00011 mg/L; if hardness 5.3-360 mg/L, cadmium benchmark = $10^{1.016[\log10(\text{hardness})]-1.71}$ / 1,000 mg/L; if hardness >360 mg/L, benchmark = 0.0077 mg/L. Long-term: if hardness < 17 mg/L, benchmark = 0.00004 mg/L; if hardness 17-280 mg/L, benchmark = $10^{0.83[\log10(\text{hardness})]-2.46}$ / 1000 mg/L; if hardness >280 mg/L, benchmark = 0.00037 mg/L.

Attachment E: 2020 Provincial and Federal Water Quality Guidelines for the Protection of Freshwater Aquatic Life

Notes (continued):

[n] *Dissolved Copper - the BC ENV guideline is computed by the British Columbia Copper Biotic Ligand Model (BC BLM).*

[o] *Copper – if hardness (as $CaCO_3$) is < 82 mg/L, copper guideline is 0.002 mg/L; if hardness 82-180 mg/L, copper guideline = $e^{0.8545[ln(hardness)]-1.465}$ * 0.0002 mg/L; if hardness >180, copper guideline is 0.004 mg/L.*

[p] *Lead - if hardness (as $CaCO_3$) is ≤ 8 mg/L the maximum concentration is 0.003 mg/L; if hardness is > 8 mg/L the maximum concentration is $e^{1.273ln(hardness)-1.460}$ / 1,000 mg/L and the 30-day mean is (3.31+$e^{1.273ln(mean[hardness])-4.704}$) / 1,000 mg/L.*

[q] *Lead – if hardness (as $CaCO_3$) is ≤60 mg/L or unknown, lead guideline is 0.001 mg/L; if hardness >60-180 mg/L, lead guideline = $e^{1.273[ln(hardness)]-4.705}$ / 1,000 mg/L; if hardness >180, lead guideline is 0.007 mg/L.*

[r] *Manganese - manganese concentration maximum = 0.01102(hardness)+0.54 mg/L and the 30-day mean concentration = 0.0044(hardness)+ 0.605 mg/L.*

[s] *Nickel - if hardness (as $CaCO_3$) is 0-60 mg/L the 30-day mean concentration is 0.025 mg/L; if hardness 60-180 mg/L the 30-day mean concentration = e(0.76 * ln[hardness]+1.06) / 1,000 mg/L; if hardness >180 mg/L the 30-day mean concentration of 0.150 mg/L.*

[t] *Nickel – if hardness (as $CaCO_3$) is ≤60mg/L or unknown, nickel guideline is 0.025 mg/L; if hardness >60-180 mg/L, nickel guideline = $e^{0.76[ln(hardness)]+1.06}$ / 1,000 mg/L; if hardness >180 mg/L, nickel guideline is 0.150 mg/L.*

[u] *Silver - if hardness is ≤ 100 mg/L the maximum concentration is 0.0001 mg/L and the 30-day mean is 0.00005 mg/L; if hardness > 100 mg/L the maximum concentration is 0.003 mg/L and the 30-day mean is 0.0015 mg/L.*

[v] *Zinc - 30-day mean concentration = 7.5 + 0.75(hardness - 90)/1,000 mg/L; maximum zinc concentration = 33 + 0.75(hardness - 90)/1,000 mg/L.*

[w] *Dissolved aluminum - if pH ≥ 6.5 the maximum concentration is 0.1 mg/L and the 30-day mean is 0.05 mg/L; if pH < 6.5 the maximum concentration is $e^{(1.209 - 2.426pH + 0.286 K)}$ mg/L where K = $(pH)^2$ and the 30-day mean is $e^{(1.6 - 3.327 (median\ pH) + 0.402 K)}$ mg/L where K = $(median\ pH)^2$.*

[x] *Dissolved cadmium – if hardness (as $CaCO_3$) is < 7 mg/L, the maximum concentration = 0.000038 mg/L; if hardness ≥7, the maximum concentration = $e^{(1.03 * ln[hardness]-5.274)}$ / 1,000 mg/L. If hardness < 3.4 mg/L, the 30-day mean concentration = 0.0000176; if hardness ≥ 3.4, the 30-day mean concentration = $e^{(0.736 * ln[hardness]-4.943)}$ / 1,000 mg/L.*

[y] *Nitrite - if chloride < 2 mg/L the maximum concentration is 0.06 mg/L and the 30-day mean is 0.02 mg/L; if chloride is 2 to 4 mg/L the maximum concentration is 0.12 mg/L and the 30-day mean is 0.04 mg/L; if chloride is 4 to 6 mg/L the maximum concentration is 0.06 mg/L and the 30-day mean is 0.18 mg/L; if chloride is 6 to 8 mg/L the maximum concentration is 0.24 mg/L and the 30-day mean is 0.08 mg/L; if chloride is 8 to 10 mg/L the maximum concentration is 0.30 mg/L and the 30-day mean is 0.10 mg/L; if chloride is > 10 mg/L the maximum concentration is 0.60 mg/L and the 30-day mean is 0.20 mg/L.*

[z] *Dissolved Zinc - the long-term Canadian Water Quality Guideline (CWQG) considers hardness, pH and dissolved organic matter (DOC). CWQG = $e^{(0.947 * (ln[hardness]) - 0.815 * [pH] + 0.398 * (ln[DOC]) + 4.625)}$ where the CWQG is expressed in dissolved zinc concentration (µ/L).*

[aa] *CCME Dissolved Manganese guideline long-term guideline is found in a look-up table with hardness and pH as the indices. The short-term guideline value = $e^{(0.878 * ln[hardness]+4.76)}$ / 1,000 mg/L.*