GOLDCORP

Coffee Gold Mine
YESAB Project Proposal
Appendix 12-B Surface Water Quality Valued Component Assessment Report

VOLUME II

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
$7Q_{10}$	Minimum 7-day average streamflow for a 1:10 year recurrence interval
BC WQGs	BC Water Quality Guidelines
BOD	Biological Oxygen Demand
CC	Coffee Creek
CCB	Cumulative Change Boundary
CCME	Canadian Council of Ministers of the Environment
CEA Area	Cumulative Effects Assessment Area
COD	Chemical Oxygen Demand
DOC	Dissolved Organic Carbon
EA	Environmental Assessment
EP	Event Pond
HC	Halfway Creek
HDPE	High-density polyethylene
HLF	Heap Leach Facility
IC	Intermediate Component
LAA	Local Assessment Area
MAD	Mean Annual Discharge
MAR	Mean Annual Runoff
MMER	Metal Mining Effluent Regulations
NAR	Northern Access Route
PMP	Probable Maximum Precipitation
Project	Coffee Gold Mine Project
PSSWQO	Proposed Site-specific Water Quality Objectives
QML	Quartz Mining License
RAA	Regional Assessment Area
VC	Valued Component
WBM	Water Balance Model
WQM	Water Quality
WRSF	Waste Rock Storage Facility
WBM	Water Balance Model
WSC	Water Survey of Canada
WUL	Water Use License
YESAB	Yukon Environmental and Socio-Economic Assessment Board
YESAA	Yukon Environmental and Socio-Economic Assessment Act
YT	Yukon Tributary

SYMBOLS AND MEASUREMENTS

Symbol / Measurement	Definition
>	Greater than
<	Less than
>=	Greater than or equal to
=<	Less than or equal to
°C	Degree Celsius
+/-	Plus or Minus
hr	Hour
km	Kilometre
km^2	Square kilometre
L	Litre
L/s	Litre per second
L/s/km^2	Litre per second per square kilometre
m	Metre
m^2	Square metre
m^3	Cubic metre
M	Million
ML	Million litres (or Megalitre)
m^3/day	Cubic metres per day
m^3/s	Cubic metres per second
mm	Millimetre
%	Percent
s	Second
t	Metric tonne
yr	Year

1.0 INTRODUCTION

This report provides an assessment of potential effects and cumulative effects from the Coffee Gold Mine (the Project) to surface water quality, an aspect of the biophysical environment identified as a valued component (VC) for the Project. The Project is a proposed open pit gold mine that will use a cyanide heap leach process to extract ore. The Project is located in west-central Yukon, and is situated approximately 130 kilometres (km) south of Dawson City (**Figure 1.1-1**). The analysis described herein pertains to the Construction, Operation, Reclamation and Closure and Post-closure phases of the Project.

The Yukon Environmental and Socio-economic Assessment Board (YESAB) defines Valued Environmental and Socio-economic Components (VCs) as elements of the environmental and/or socio-economic systems valued for environmental, scientific, social, aesthetic, or cultural reasons. A VC may be supported by one or more Intermediate Components (ICs), defined as a component in an intermediate position along a pathway of effects leading to one or more receptors or VCs.

Surface water quality represents an environmental component of importance to key stakeholders, including the Aboriginal communities of White River First Nation (WRFN), First Nation of Na-Cho Nyak Dun (FNNND), Selkirk First Nation (SFN), and Tr'ondëk Hwëchin (TH) First Nation, and is protected under both territorial (e.g., *Environmental Management Act* [2004], *Mines Act* [1996]) and federal (e.g., Metal Mining Effluent Regulations [MMER; SOR/2002-2222] under the *Fisheries Act* [1985b]) legislation.

Surface water quality constitutes the physical, chemical, biological, and aesthetic characteristics of water, which are influenced by a variety of regional and local factors including rock weathering, surface transport, biological activity, and anthropogenic influences. For the assessment of the Project, the surface water quality VC was informed by the following intermediate and valued component assessments: groundwater IC, surface hydrology IC, air quality and greenhouse gas emissions IC, and surficial geology, terrain, and soils VC.

Surface water quality, in turn, may directly or indirectly influence other environmental and/or socio-economic components. For the assessment of the Project, seven VCs were identified as having the potential to be influenced by the surface water quality VC: fish and fish habitat, vegetation, wildlife and wildlife habitat, birds and bird habitat, social economy, land and resource use, and community health and well-being.

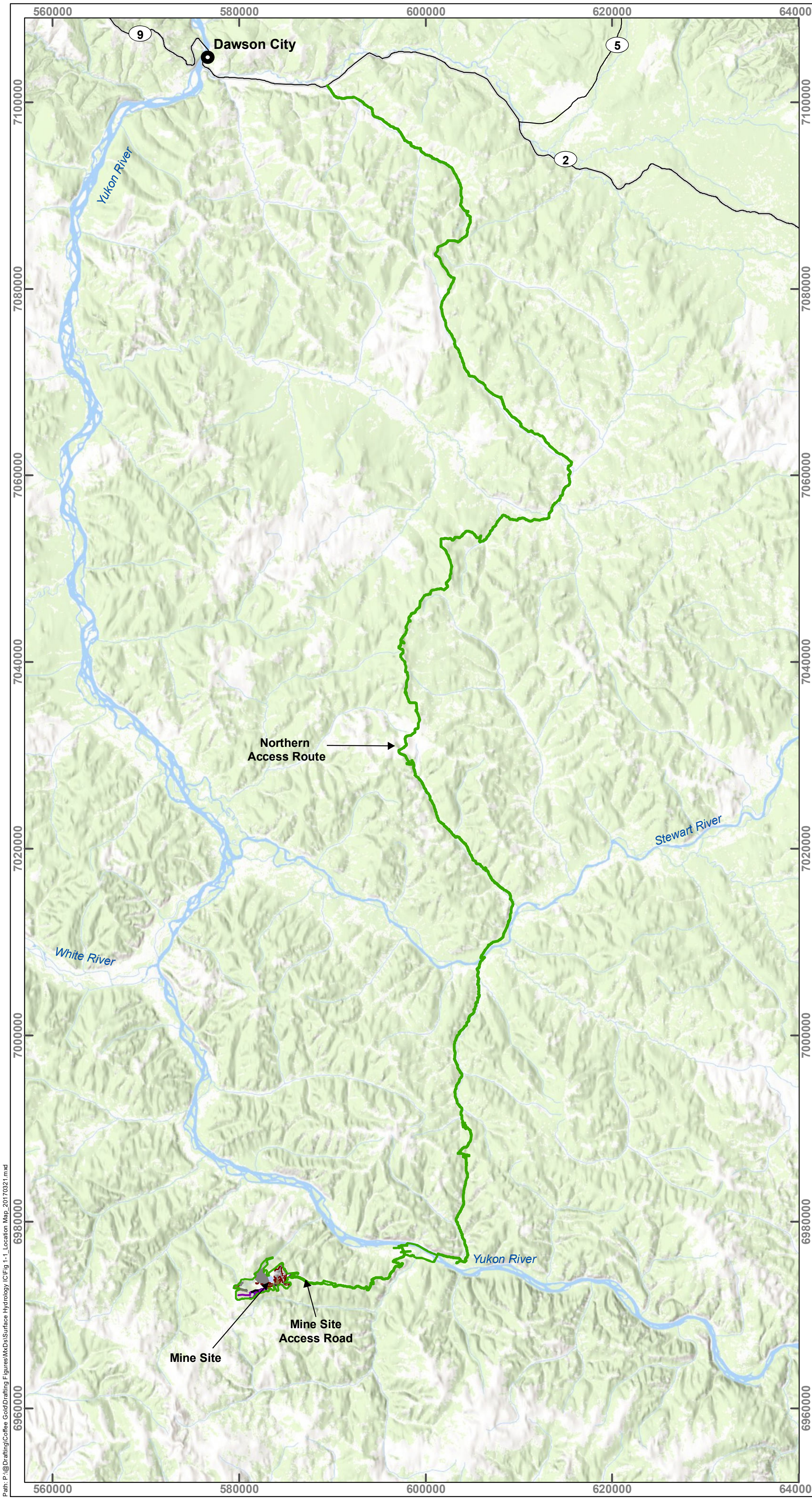
This report includes the following sections:

- **Section 1.0** presents the scope of the analysis and the rationale for the selection of the surface water quality VC, discusses indicators through which the VC will be assessed, and also describes the spatial, temporal, administrative, and technical boundaries for the assessment.
- **Section 2.0** identifies any VC-specific assessment methods that differ from the methods set out in Section 5.0 Effects Assessment Methodology of the Project Proposal. Specifically, a description of how the analysis was informed by Traditional Knowledge (TK) through consultation and

engagement with affected First Nations is provided. This section also describes the water quality model and screening approach that underpins the surface water quality VC assessment.

- **Section 3.0** summarizes baseline surface water quality programs and conditions to characterize existing surface water quality in the catchments proximal to or potentially affected by the Project.
- **Section 4.0** presents a description of potential interactions between surface water quality and proposed Project components and activities, identifies potential adverse effects to water quality, and outlines proposed measures to mitigate potential effects. Project-related residual effects to surface water quality are also presented, followed by a description and assessment of the significance of potential residual adverse effects to surface water quality.
- **Section 5.0** describes consideration of potential cumulative effects to surface water quality from the Project in combination with past, present, and reasonably foreseeable future projects and activities located within the region.
- **Section 6.0** provides a summary of the surface water quality VC assessment.
- **Section 7.0** outlines the effects monitoring plan to be implemented to verify predicted changes and the effectiveness of proposed mitigation measures for the VC. Further, this section describes the adaptive management strategies that will be in place to address changes falling outside the range of predictions presented in this appendix.

The remaining sub-sections of **Section 1.0** outline the scope of the surface water quality VC assessment, beginning with a description of issues scoping process in **Section 1.1**. In **Section 1.2**, the process used to select surface water quality as a VC is described, which includes the identification of linkages with other ICs and VCs. The indicators that will be used to evaluate potential adverse effects and characterize residual effects to the surface water quality VC are discussed in **Section 1.3**. Finally, the spatial and temporal boundaries for the assessment are defined in **Section 1.4**, along with rationale for their selection.



COFFEE PROJECT

Location Map, General Arrangement for the Coffee Project

Legend

- Municipality
- Highway
- Project Footprint

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Figure 1.1-1	Date: Mar 21, 2017	Drawn by: G.M.	Reviewed: J.S./L.F.

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Path: P:\@Drafting\Coffee Gold\Drafting Figures\MxDs\Surface Hydrology (C)\Fig 1.1-1_Location Map_20170321.mxd

1.1 Issues Scoping

This section describes the scoping considerations used to identify VCs potentially affected by Project activities, and more specifically to identify and understand issues related to surface water quality.

The identification and characterization of Project VCs is intended to focus the Project Proposal assessment process on key components of the biophysical and socio-economic environments that have environmental, social, economic, heritage, or health value. Components identified as VCs (and ICs) are recognized as having potential or a perceived potential to be affected by the proposed Project, either directly, or indirectly through changes to the baseline condition of other environmental components. The identification of VCs occurred through a consultation process with key stakeholders, including the Aboriginal communities of WRFN, FNNND, SFN, and TH, and from scientific information, previous project experience, and federal and territorial legislation, where relevant.

Goldcorp Inc. (Goldcorp) has undertaken an engagement and consultation process, as defined under section 50 (3) of the *Yukon Environmental and Socio-economic Assessment Act* (YESAA), to support the scoping of issues for the Project (refer to report Sections 3.0 through 3.6 for detail on the consultation program). Goldcorp continues to consult and engage with affected First Nations and communities, government agencies, and interested persons and/or other stakeholders who may be interested in the Project and its related activities.

This consultation and engagement process has included the assembly of technical working groups established with First Nations, government departments, community meetings, one-on-one and small group meetings, and ongoing communications such as print communication, newsletter, and website updates, including specific presentations and discussions regarding key themes of interest and exploration of candidate VCs to represent the themes. An initial assessment of available TK confirms that First Nations acknowledgement that air, land, and water resources are inextricably linked, and furthermore, the maintenance and protection of these resources is highly important to people and biota (fish, wildlife and plants) alike.

Several First Nations individuals and resources consulted during the engagement process emphasized the importance of the Coffee Creek corridor, including the salmon runs, wildlife and vegetation it supports, as well as its traditional usage for travel. Traditional use of the area is well documented, and fish camps were set up annually near the mouth of Coffee Creek by multiple First Nations groups (e.g., Bates and DeRoy 2014, Tr'ondëk Hwëch'in 2012, Dawson Indian Band 1998, Easton *et al*. 2013). Overall, the themes identified through the engagement and consultation process provide a strong supporting basis for including surface water quality as a VC for the Project.

1.2 SELECTION OF SURFACE WATER QUALITY VC

Surface water quality was selected as a VC for the Project Proposal. The proposed ICs and VCs that were selected for assessment for the Project are summarized in Section 5.1.2 – Effects Assessment Methodology, Selection of Valued Environmental and Socio-economic Components of the Project Proposal. The selection process followed the guidelines set out in Section 5.1.2 of the Project Proposal, and ultimately determined that this environmental component would be most effectively assessed as a VC. This effects assessment considers a single VC (surface water quality), whereby changes are evaluated using indicators that are relevant, practical, measurable, responsive, accurate, and predictable.

In addition to professional knowledge and judgement, the selection process involved consideration of available TK, scientific and other information, input provided during the Project's consultation and engagement program, and discussions with other members of the Project team.

1.2.1 CANDIDATE VC

As a result of the issue scoping process described in **Section 1.1**, surface water quality was identified as the candidate VC for the assessment of the Project. As a component of the natural environment, surface water quality incorporates the biological, chemical, and physical characteristics of water.

Surface water quality is intimately linked to aquatic ecosystem processes, and has the potential to be modified by the Project directly (e.g., controlled discharge of mining-affected waters to receiving creeks) and indirectly (e.g., non-controlled discharge of mining-affected groundwater from open pit development). Potential issues relating to surface water quality are of primary importance to stakeholders and are anticipated to have a high degree of interaction with other VCs and ICs.

Traditional knowledge (TK) speaks to an inherent value in surface water quality: "…as soon as something goes into the water that's not supposed to be there, the water — it spreads so much quicker than anything in the ground, right? Like, it's just — it goes like that. And then it affects the entire territory. …And it affects everything that that water touches. And water is also underneath the ground. So, everything — like, water is, like, the most — probably the most sacred thing". W09 21-Aug-2014 (Bates and DeRoy, 2014, The Firelight Group, with White River First Nation).

Effect pathways between surface water quality and other ICs and VCs are also noted in TK. Linkages between surface water quality and fish are well-noted ("If we pollute the water it hurts the fish" (Tr'ondëk Hwëchin, 2012)), as well as linkages with vegetation, wildlife and wildlife habitat, and birds and bird habitat ("It was noted that contamination of water leads in turn to contamination of plants, fish and animals that drink or live around the water." (Bates and DeRoy, 2014). This is further linked with potential community health and well-being effects for the WRFN, as quoted below, alongside the FNNND, SFN, and TH that described traditional use within the Project area: "Potential project interactions from the Coffee Gold Project with WRFN hunting, trapping, fishing and gathering plants would include: …Potential contamination of water, plants and animals, and concerns over contamination, deterring WRFN members from harvesting resources in the project footprint, LSA, RSA and downstream in the Yukon River"[1] (Bates and DeRoy, 2014). As such, potential effect pathways and linkages between surface water quality and other ICs and VCs play an important role in the consideration of potential Project effects.

The ability to measure, quantify and monitor potential effects to surface water quality is straightforward and well-established. Surface water quality monitoring typically entails the measurement of one or more chemical, biological or physical constituents in a sample. As such, protocols and analytical methods for the collection and analysis of samples to evaluate potential Project-related effects are well-established. Water quality modelling, as a means to predict future potential effects, is also a well-developed discipline, and commonly forms an integral component of mine project design and environmental impact assessment.

The reasons outlined above for selecting the surface water quality candidate VC as a VC for the assessment of the Project are summarized in **Table 1.2-1**.

[1] LSA refers to local study area, and RSA refers to regional study area.

Table 1.2-1 Candidate Valued Components for Surface Water Quality – Evaluation Summary

Candidate VC	Project Interaction			Project Partner and Third Party Input		Supports the Assessment of Which Other VC?	Selected as a VC?	Decision Rationale
	Interaction?	Project Phase / Project Component / Activity	Nature of Interaction	Source	Input			
Surface Water Quality	Yes	Project related activities are expected to interact with this VC in all phases of the Project life.	The Project has the potential to change levels of certain chemical, biological and/or physical constituents in the Project receiving environment	First Nations Yukon Territorial Government Federal Government Public Stakeholder	• First Nations have identified the fundamental importance of surface water quality and linkages with other ICs/VCs. • Indicate surface water quality is valued, linked to several other ICs/VC, and should be protected. • Several pieces of territorial and federal legislation govern the use of and impact to water quality. • No public stakeholder comments were received.	The surface water quality VC assessment will support the assessments of the following VCs: fish and fish habitat, vegetation, wildlife and wildlife habitat, birds and bird habitat, social economy, land and resource use, and community Health and well-being.	Yes surface water quality	Surface water quality was selected as an VC due to: 1) The potential for Project-related activities to affect water quality in receiving creeks in the Project area; and 2) Its strong linkages with other ICs/VCs.

1.2.2 SELECTED VC

Surface water quality was screened for inclusion as a VC as a result of the issues scoping process. Water quality in lakes and streams in the region is highly valued by WRFN, FNNND, SFN, TH Nation, local people, as well as the territorial and federal governments. This VC represents a key aspect of environmental health, holds inherent value in TK, and is linked to other ICs and VCs.

The effects pathways along which potential Project-related effects could occur were examined to understand the inter-relationships between components. There are three ICs that inform the surface water quality VC effects assessment including groundwater, surface hydrology, and air quality and greenhouse gas emissions (the assessments of which are described in Appendices 7-B to 9-B of the Project Proposal, respectively), as well as one VC - surficial geology, terrain, and soils (see Appendix 11-B). There are seven VCs receptors along the effects pathway that are informed by the surface water quality VC:

- Fish and fish habitat (Appendix 14-B)
- Vegetation (Appendix 15-B)
- Wildlife and wildlife habitat (Appendix 16-B)
- Birds and bird habitat (Appendix 17-B)
- Social Economy (Appendix 21-A)
- Land and Resource Use (Appendix 24-A), and
- Community health and well-being (Appendix 25-A) - VC Assessment Report

Components considered likely to be receptors of potential environmental or socio-economic effects of the Project were selected as VCs for the purpose of this assessment. Surface water quality was identified as an IC along the pathway of effects leading to the fish and fish habitat, as an example, but as stated previously, surface water quality also has the potential to be affected by intermediate and valued components (e.g., groundwater IC and surficial geology, terrain and soils VC). Ultimately, surface water quality was selected as a VC (without biological, chemical, and physical subcomponents) due to its high importance in the natural and human environment, as identified during the issues scoping process. This approach reflects the values expressed in TK and relevant territorial and federal regulation and guidelines, which consider water quality as a whole component rather than as separate constituents or subcomponents that characterize water quality.

1.3 INDICATORS

Indicators are quantitative or qualitative measures used to describe existing VC conditions and trends. They are used to evaluate potential Project effects and cumulative effects to the VC. The BC EAO (2013) outlines the necessary attributes of the indicators used to measure the existing condition of a VC (or IC), and the potential changes that may result from Project development (described in Section 5.0 of the Project

Proposal). For this assessment, indicators of surface water quality include total suspended solids (TSS), turbidity, other physical parameters (pH, conductivity, hardness, total dissolved solids), cyanide species (total cyanide, weak acid dissociable cyanide), nutrients (total phosphorus and nitrogen species), biological oxygen demand (BOD) and chemical oxygen demand (COD), and total and dissolved metals.

Project-related effects to surface water quality during the life of the Project have the potential to occur through pathways, from various sources, many of which overlap in terms of definition and scope. For the purposes of the surface water quality effects assessment, Project-related effects to surface water quality were identified in order to identify appropriate indicators. Overall, seven mechanisms were identified that may result in potential effects to surface water quality:

- Erosion and sedimentation
- Leaching from disturbed mine materials/waste (or disturbed materials along the Northern Access Route (NAR))
- Leaching of nitrogen residues generated from blasting
- Discharge of treated camp wastewater
- Leaching of Heap Leach Facility (HLF) residues
- Groundwater and surface water interactions and seepage, and
- Atmospheric deposition.

Potential effects from these mechanisms are described and evaluated in further detail in Section 4.2. Each effect is associated with characteristic indicators for surface water quality, which were identified based on Project monitoring programs, previous experience at similar projects, and scientific literature. Typically, a Project-related effect is expected to be represented as an increase to one or more indicators relative to baseline or background conditions. **Table 1.3-1** summarizes the rationale for selection of these indicators.

Table 1.3-1 Indicators for Surface Water Quality

Indicator	Rationale for Selection
TSS and turbidity concentration	A measurable increase from background levels will identify Project-related effects from: **Erosion and sedimentation** - associated with surface disturbance and/or elevated suspended sediments in mine effluent discharges **Atmospheric deposition** – associated with surface disturbance, roadway traffic, and particulate emissions from plant site.
Physical parameters (conductivity, pH, hardness, TDS)	A measurable change from background levels will identify Project-related effects from: **Leaching of disturbed mine materials/waste** – associated with contact water from waste rock storage facilities (WRSFs), ore stockpiles, exposed pit surfaces, or surface disturbances (e.g., new road construction). **Groundwater and surface water interactions and seepage** – associated with seepage and groundwater (higher in major ions) recharging to surface waters (lower in major ions).
Cyanide species (CN_{WAD}, CN_T)	A measurable increase from background levels will identify Project-related effects from: **Leaching of HLF residues** – associated with application of cyanide for gold extraction at the HLF.
Nutrient (TP, NH_3, NO_2, NO_3) concentrations	A measurable increase from background levels will identify Project-related effects from: **Leaching of nitrogen residues generated from blasting** – associated with nitrogen-based explosive use. **Leaching of HLF residues** – associated with application of cyanide for gold extraction at the HLF. **Discharge of camp wastewater** – associated with effluent from the camp and administrative facilities
Biological oxygen demand (BOD) and chemical oxygen demand (COD)	A measurable increase from background levels will identify Project-related effects from: **Discharge of treated camp wastewater** – associated with effluent from the camp and administrative facilities
*Total and dissolved metals concentrations (*e.g., Al, As, Sb, Co, Cr, Fe, Pb, Hg, Ni, Se, U and Zn.)	A measurable increase from background levels will identify Project-related effects from: **Erosion and sedimentation** – with increase total (not dissolved) metal fraction only, associated with surface disturbance and/or elevated suspended sediments in effluent discharged from Project ponds. **Atmospheric deposition** – associated with surface disturbance, roadway traffic, particulate or soluble emissions from plant site. **Leaching of disturbed mine materials/waste** – associated with contact water from WRSFs, ore stockpiles, exposed pit surfaces, or surface disturbances (e.g., new road construction). **Leaching of HLF residues** – associated with application of cyanide for gold extraction at the HLF. **Groundwater and surface water interactions and seepage** – associated with seepage and groundwater (higher in certain trace elements) recharging to surface waters (lower in certain trace elements).

The indicators selected will be used to evaluate potential adverse changes, the subsequent effectiveness of mitigation measures, and to characterize potential residual adverse changes. These indicators are common metrics used to characterize water quality, and each one has a direct physical linkage to the proposed Project activities (e.g., low flows may be altered by waste rock placement, both of which are linked to surface water quality, and fish and fish habitat).

1.4 Establishment of Assessment Boundaries

The assessment boundaries define the extents within which the surface water quality VC effects assessment (and supporting studies and predictive modelling) has been conducted. These boundaries encompass where (the spatial extent) and when (the temporal duration) the Project is reasonably expected to interact with the VC. The spatial and temporal boundaries for the assessment of the surface water quality VC are described below, but in general, they include all drainages that have the potential to be directly or indirectly affected in the Construction, Operation, Reclamation and Closure, and Post-closure phases of the Project. The selection of spatial and temporal boundaries is a key component of the effects assessment process, as it informs the selection of monitoring locations, boundaries for predictive models, and locations for predictive model outputs.

Consideration is also given to any administrative or technical boundaries or constraints encountered in the characterization baseline conditions or for effects assessment (i.e., limitations associated with predicting or measuring Project-related changes)

1.4.1 Spatial Boundaries

The Local Assessment Area (LAA), Regional Assessment Area (RAA) and the Cumulative Effects Assessment Area for surface water quality are defined in **Table 1.4-1.** The LAA and RAA are shown in **Figure 1.4-1**, **Figure 1.4-2** (which focuses on the Mine Site area), and **Figure 1.4-3** (which focuses on the Northern Access Route)**.**

Local Assessment Area – For Project components and activities at the Mine Site area, the LAA for the surface water quality VC includes catchments within the Project area. These are Latte Creek, Yukon Tributary 24 (YT-24), and Halfway Creek, as well as downstream watercourses including Coffee Creek (downstream of Latte Creek) and the Yukon River (downstream of Coffee, YT-24, and Halfway creeks)

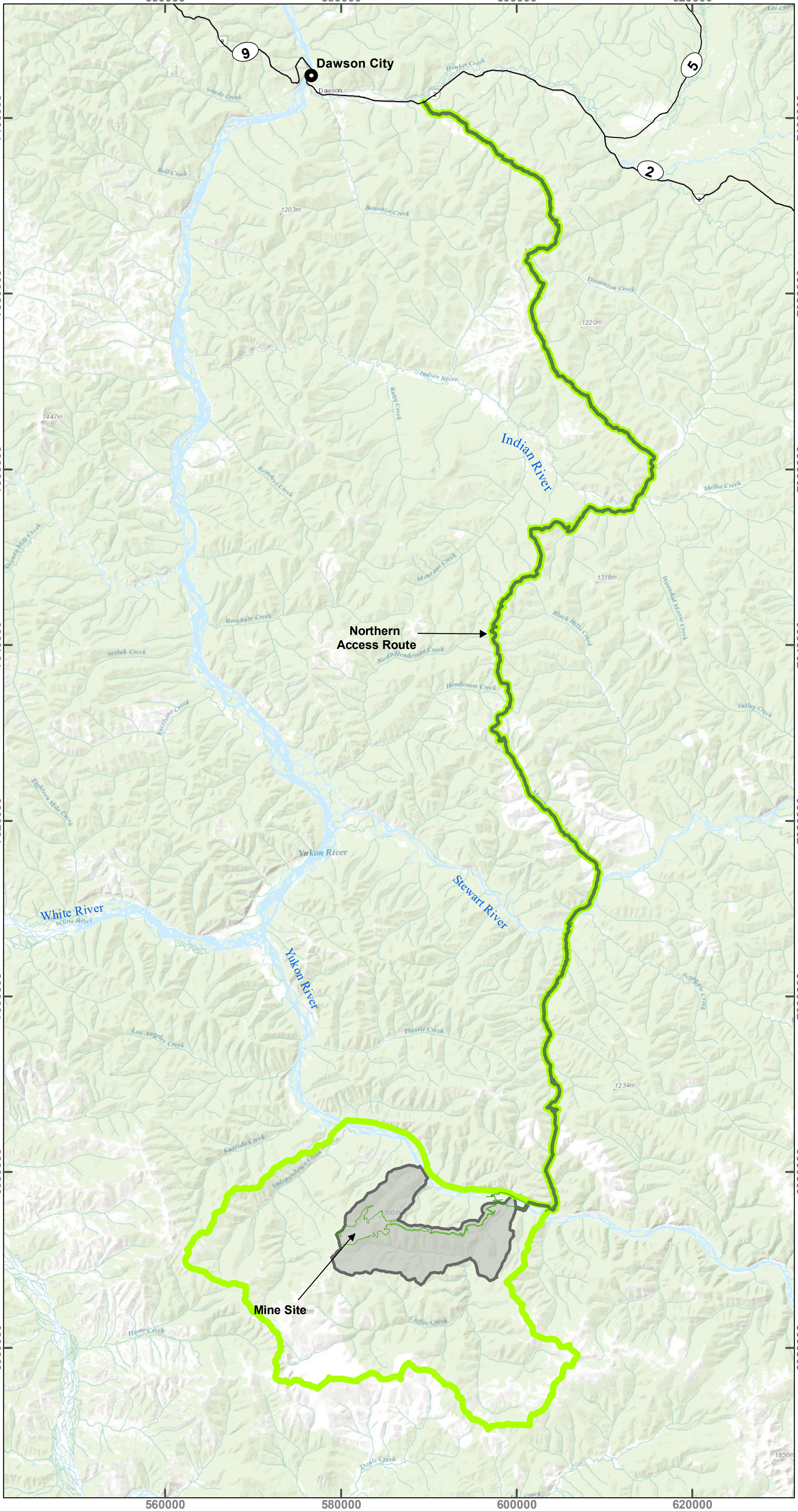
For Project components and activities outside of the Mine Site area, the LAA extends east and north to include the Northern Access Route (NAR), the airstrip, and the Coffee exploration camp and airstrip, as shown in Figure 1.4-2. Along the NAR, the LAA boundary is defined as 100 m from the centerline on either side of the road (i.e., 200 m width in total) (**Figure 1.4-3**).

The LAAs for and beyond the Mine Site area represent the spatial extent of where direct and indirect Project-related effects are anticipated to occur.

Regional Assessment Area – The RAA for the Mine Site area incorporates the LAA plus the entirety of the Coffee Creek watershed (including the portion of the watershed upstream of the confluence with Latte Creek), Independence Creek, and the section of the Yukon River that spans the confluences with Independence and Coffee creeks (see **Figure 1.4-1** and **Figure 1.4-2**).

Upstream of the Coffee Creek confluence with the Yukon River, the RAA boundary extends north and east slightly to include the proposed Yukon River barge landing and proposed borrow areas associated with the Northern Access Route, two small tributaries on the south bank of the Yukon River that are situated to the east of Coffee Creek (**Figure 1.4-3**), and the Northern Access Route to its northern terminus at the junction with Highway 2.

The RAAs, which includes the LAAs, provide a regional context for the analysis of Project-related changes in the LAA.



COFFEE GOLD MINE

Local and Regional Assessment Areas for Surface Water Quality

Legend

- Municipality
- Highway
- Local Assessment Area
- Regional Assessment Area
- Project Footprint

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0 5 10 15

Kilometres

NAD 1983 UTM Zone 7N

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Figure 1.4-1	Date: Mar 24, 2017	Drawn by: AL	Reviewed: MG

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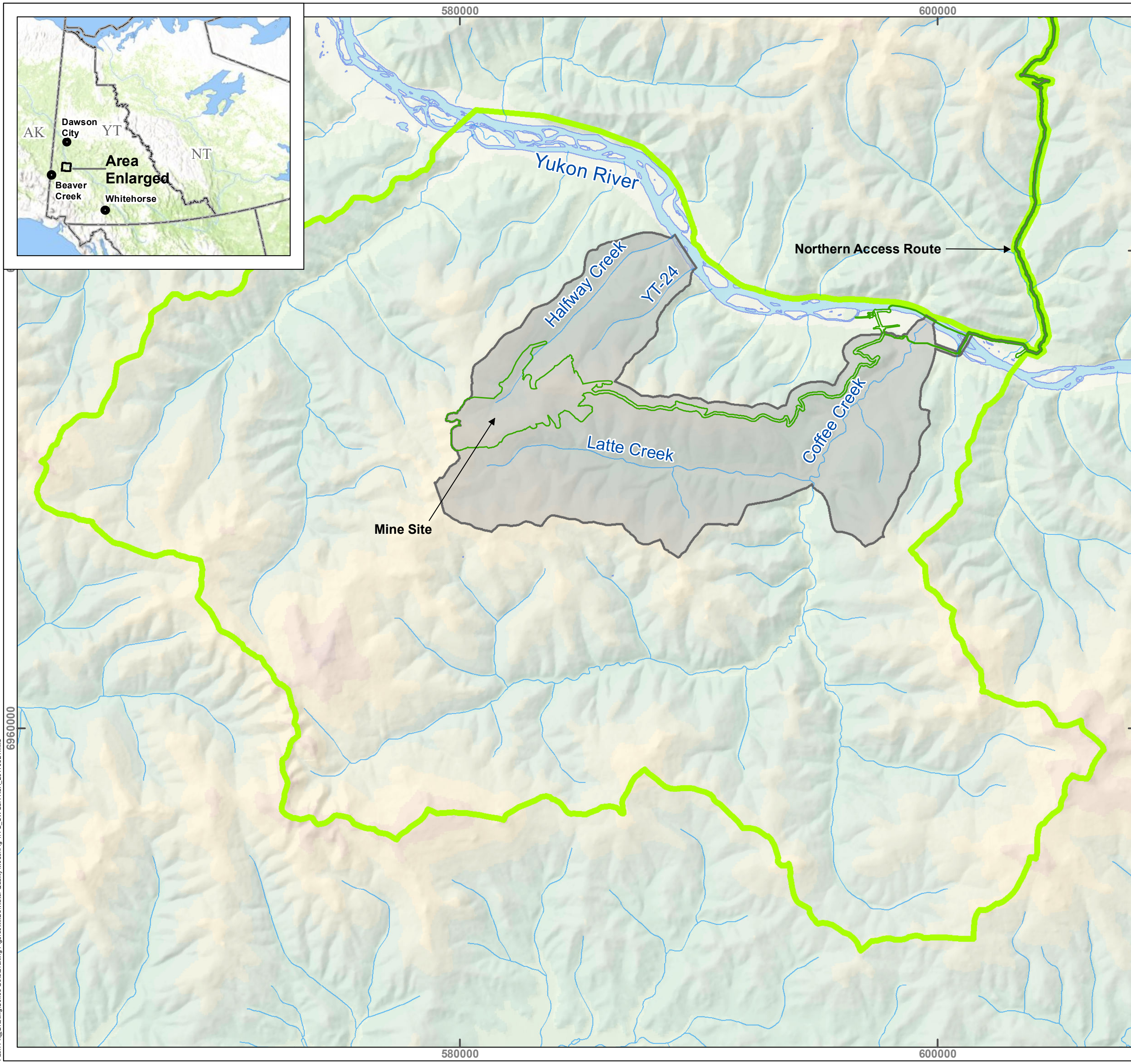

COFFEE GOLD MINE

Local and Regional Assessment Areas for Surface Water Quality in Mine Site Area

Legend
- Municipality
- Project Footprint
- Local Assessment Area
- Regional Assessment Area

N

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Kilometres

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Figure 1.4-2	Date: Mar 24, 2017	Drawn by: AL	Reviewed: NM

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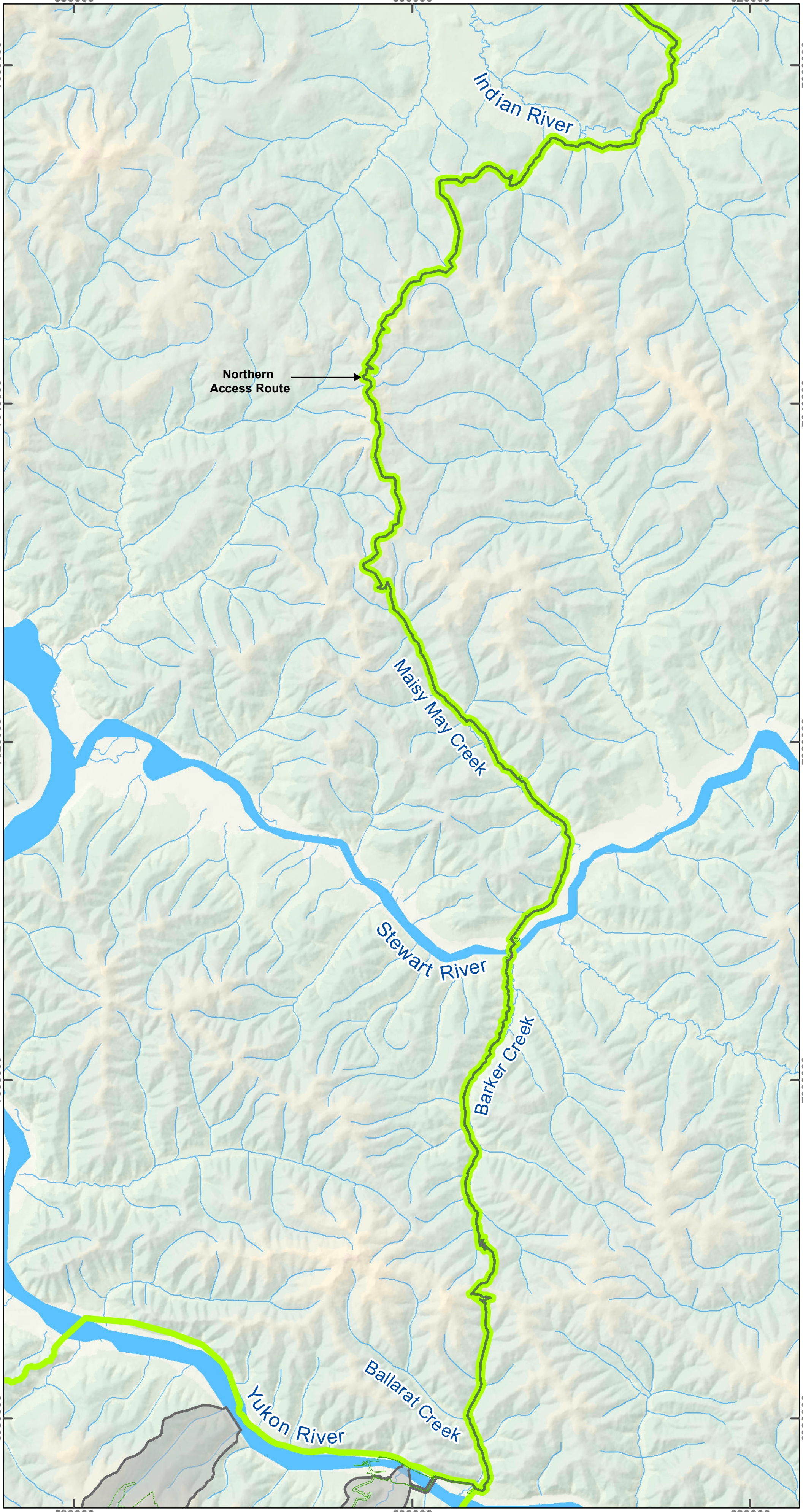

COFFEE GOLD MINE

Local and Regional Assessment Areas for Surface Water Quality along Northern Access Route

Legend

- Municipality
- Local Assessment Area
- Regional Assessment Area
- Project Footprint

N

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Kilometres

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1.4-3	Mar 24, 2017	AL	MG

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Cumulative Effects Assessment area

An assessment area for determining future cumulative effects is not required since there are no reasonably foreseeable projects or activities expected to influence or change the characteristics of surface water quality in conjunction with Project-related effects. The CEA Assessment is presented in further detail in **Section 5.0.**

Table 1.4-1 Spatial Boundary Definitions for Surface Water Quality

Spatial Boundary	Description of Assessment Area
Local Assessment Area	The Halfway Creek and Yukon Tributary watersheds, Latte Creek and Coffee Creek downstream of the confluence with Latte Creek to the Yukon River. The LAA also includes the alignment of the proposed Northern Access Route, including 100 m on either side of the road along its entire length.
Regional Assessment Area	The entirety of the LAA, the Coffee Creek watershed (including the portion upstream of the confluence with Latte Creek), Independence Creek and the section of the Yukon River that spans the confluences with Independence and Latte Creeks.
Cumulative Effects Assessment area	Not applicable.

The identification of the Project spatial boundaries was partly informed by TK. The Coffee Creek drainage is part of a traditional travel corridor of environmental and cultural significance (Tr'ondëk Hwëch'in, 2012), while "…many WRFN study participants report that the mouth of Coffee Creek was an important salmon fishery, known throughout the region for its fish…" (Bates and DeRoy, 2014). The value of Coffee Creek as a traditional fishing resource and gathering place is echoed by several First Nations (e.g., Tr'ondëk Hwëch'in, 2012; Easton et al., 2013; Yukon River Commercial Fishing Association & TH, 1997). Within the context of the LAA, the statement that "the smallest creeks feed our rivers. We need to protect them too" (Tr'ondëk Hwëch'in, 2012), is suggestive of the importance of assessing potential local effects to receiving creeks, Latte Creek, Coffee Creek, YT-24 and Halfway Creek, despite their small catchment size relative to the Yukon River.

Within the Yukon River, the RAA was established so as to align with the regional study area for the Hydrology IC and the RAA for the fish and fish habitat VC.

1.4.2 Temporal Boundaries

The specifics pertaining to the Project's Construction, Operation, Reclamation and Closure, and Post-closure phases are described in the Project Proposal (Section 2.0 Project Description). The temporal boundaries of the surface water quality VC ultimately reflect those periods during which planned Project activities may reasonably be expected to interact with the VC. As such, the temporal boundaries of the surface water quality effects assessment span the entire Project life, beginning with the Construction phase (Q2 Year -3) and ending with the Post-closure phase.

Temporal boundaries for the surface water quality assessment (and predictive modelling) correspond to the Project phases and schedule presented in Project Description provided in Section 2.0 or the Project Proposal). The Construction phase occurs from Q2 Year -3 to end of Year -1 Year -2. Operation phase is expected to occur over a 12 year period, from Year 1 to end of Year 12, while the Reclamation and Closure phase is expected to last 11 years, from Year 13 to Year 23. The Post-closure phase begins in Year 24.

In the water balance model, the Post-closure phase is modelled out to the year 2100 to fully assess potential changes as part of the surface water quality VC analysis. This far-future time horizon was selected as the climate change projections that were incorporated into the water balance model base case terminate in this year.

1.4.3 Administrative Boundaries

No administrative boundaries were encountered during the collection of surface water quality data, or during the modelling and prediction of potential Project-related effects to surface water quality.

1.4.4 Technical Boundaries

No technical boundaries were identified during the assessment of potential Project-related effects to surface water quality. However, technical limitations were encountered during water quality sampling in the LAA stream catchments during winter months as part of the baseline water quality monitoring program. From the months of December through March, the LAA experiences extensive stream channel icing and low flow conditions. While flow is still present in certain catchments as a result of groundwater discharge, it is often split between the channel edges and subterranean through the bedload. Therefore, stream flow is commonly too low to allow for the collection of representative water quality samples, and typically requires extensive ice removal, that would lead to the potential for sample contamination. Samples collected under these conditions can be subject to a much higher level of uncertainty compared to samples collected during open water conditions.

A strong relationship exists between certain water quality parameters and streamflow volumes in the Project area streams (see **Appendices 12-A** and **12-C**). As such, the robust water quality and quantity relationship established for modelling purposes was used to reasonably estimate background water quality in these catchments during low-flow winter months.

2.0 ASSESSMENT METHODS

The surface water quality assessment, including the analysis of Project-related effects, cumulative effects, and changes due to accidents and malfunctions, was conducted according to the methods set out in **Section 5.0** of the Project Proposal. The following sections describe assessment methods specific to surface water quality, including details of the methods used to model surface water quality, to screen or evaluate water quality predictions, and to assess potential residual effects.

The potential effects to surface water quality from the Coffee Gold Mine were quantitatively predicted using a numeric water balance model (referred to hereafter as WBM). A description of Project components included in the model is presented in Appendix 12-C. The model was developed in the GoldSim platform, and incorporates expected flows and water quality for relevant sources, which include both contact water from mine facilities, as well as non-contact water that interacts with water from the mine site. Flows and associated water quality are combined in the GoldSim model to derive predicted concentrations for 25 parameters (surface water quality indicators), at ten specific locations in the receiving environment (referred to as model nodes), at monthly time steps for a total of 1008 months (84 years). This chapter provides an introduction and general overview of the WBM including source terms, and model sensitivities.

Flows are estimated using a WBM, which has been developed with consideration of baseline flow measurements at a number of monitoring stations, as well as certain assumptions and predictions related to the flow regime in relevant catchments and the anticipated effects of climate change. A more detailed description of the water balance model, including the assumptions and calculations underlying it, is provided in Appendix 12-C.

Water quality inputs, or source terms, are based on a set of assumptions that reflect empirical observations from the mine site, analogues (comparable mine sites), baseline data, and/or the results of various geochemical and metallurgical tests that have been undertaken to provide a basis for assigning likely future water quality associated with specific mine components. Source terms are fully described, including the assumptions and calculations underlying them, in Appendix 12-D.

2.1 PROJECT INTERACTIONS, EFFECTS AND MITIGATION

Throughout the different phases of the Project, various activities have the potential to result in an effect to surface water quality. Potential Project interactions with surface water quality that may have a substantive influence on the short- or long-term integrity of this VC have been identified (**Section 4.1**), and potential effects arising from potential interactions are characterized relative to existing conditions (**Section 4.2**). Mitigation measures proposed to avoid or reduce potential effects are identified (**Section 4.3**). Several mitigation measures are addressed through Project design, including Project scheduling and water management. However, since all effects cannot be mitigated through design, additional mitigation measures will be implemented, and are set out in various management plans, as summarized in **Section 4.3.2**. The WBM incorporates the site-wide mitigation strategies developed for the Project, in the sense that mitigation that is intended has been considered in deriving source terms for specific mine components.

2.2 WATER QUALITY MODEL

This section describes the modelling approach and assumptions associated with the generation of water quality predictions for the Project. An overview of the model is provided, followed by a description of the water balance model, the geochemical source terms, model assumptions and model sensitivity cases. The full results data set is presented in Appendix 12-C-5, while this section presents the Base Case model results at key surface water quality modelling locations.

2.2.1 OVERVIEW

The WBM developed for the Project predicts water quality for key locations within the receiving environment throughout all phases of the Project.

The model generally employs a mass balance approach that combines the loadings associated with background flows and mine-affected flows for a series of climate realizations (i.e., climate scenarios that were developed based on a 28-year climate record, and described more fully in Appendix 12-C). The model was developed in GoldSim and accounts for background water quality, runoff volumes reporting from undisturbed portions of watersheds and regional groundwater, as well as chemical loads emanating from mine-related facilities (e.g., pits and waste rock dumps) and water management structures (e.g., contact water ponds and ditches).

2.2.1.1 Model Phases

The model accounts for mine-related activities associated with four distinct phases of the Project: Construction, Operation, Reclamation and Closure, and Post-closure, as described above in **Section 1.4.2**. A general overview of mine-related activities and facilities that have the potential to alter surface water quality is provided below by phase. The facilities and the water management structures as they relate to the different catchment areas are illustrated in **Figure 2.2-1**.

Construction (Year -3Q2 to Year -1):

- Clearing and grubbing of mine infrastructure areas
- Development of Latte and Double Double pits
- Development and use of Alpha waste rock storage facility (WRSFs)
- Development and use of stockpiles for temporary storage of vegetation and topsoil, run-of-mine (ROM) ore, and crushed ore
- HLF construction, including water management infrastructure
- Development and use of site water management infrastructure (e.g., diversion ditches, sediment control ponds and sumps), and
- Construction of crusher, process plant, airstrip, NAR, mine site service and haul roads, power generation facility, and camp.

Operation (Year 1 through Year 12):

- Development of Kona Pit and Supremo Pit, and continued development of the Double Double and Latte Pits, and dewatering of pits, as required
- Continued development and use of Alpha WRSF, development and use of Beta WRSF, and continued use of all stockpiles, and mine site roads and the NAR
- Operation of crusher and process plant, and continued staging of HLF construction (including a third event pond in Year 4)
- Progressive closure and reclamation of the HLF
- Progressive reclamation of disturbed areas within mine site footprint
- Progressive reclamation of Alpha and Beta WRSFs
- Ongoing contact and non-contact water management, pit dewatering as required, and
- Installation of HLF water treatment facility by Year 9.

Reclamation and Closure (Year 13 through Year 23):

- Closure of Supremo Pit
- Dismantling of ROM stockpile, crusher facility, process plant and all support infrastructure;
- Closure of HLF (final complete rinsing estimated to occur in Year 15) and related water management structures (Year 20), including operation of water treatment facility for HLF rinse water (Year 9 to 20), and
- Decommissioning of sediment ponds and HLF water treatment facility (Year 23).

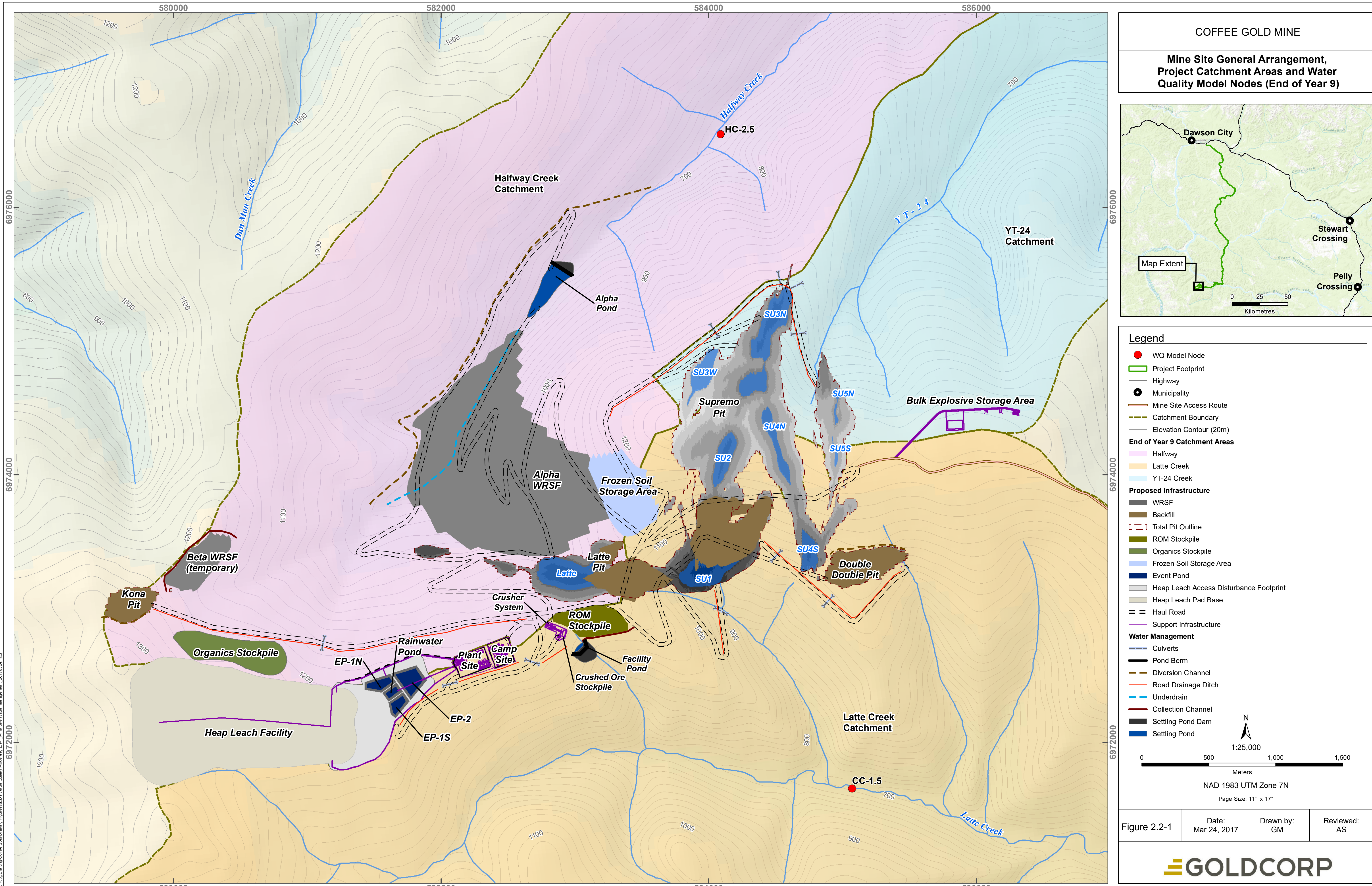
It is assumed that the mine will be fully reclaimed with no active treatment or mitigation required during the Post-closure phase (commencing in Year 24). The modelled Post-closure phase incorporates the effect of a conservative climate change scenario as defined by the Intergovernmental Panel on Climate Change.

2.2.1.2 Model Nodes

The receiving environment model nodes are intended to represent surface water quality monitoring points downstream of mine infrastructure. The NAR is excluded from the model. There are 10 model nodes, which are illustrated in **Figure 2.2-2** and described as follows:

- CC-1.5 – Latte Creek, immediately downstream of the principle point of discharge from the South Pond.
- CC-3.5 – Latte Creek, immediately upstream of the Latte Creek-Coffee Creek confluence. Project-affected discharges reporting to CC-1.5 will become more dilute as they approach CC-3.5.
- CC-0.5 – Coffee Creek, immediately upstream of Latte Creek-Coffee Creek confluence. The Project will not influence water quality at or above this node. Therefore, the predicted water quality at this node reflects expected 'background' conditions.
- CC-4.5 – Coffee Creek, upstream of the confluence with the Yukon River. Water quality at this station reflects combined surface flows from upper Coffee Creek (non-Project-influenced) and Latte Creek (Project-influenced).
- YRdsCC45 – Yukon River, immediately downstream of Coffee Creek confluence.
- YT-24 – a tributary located immediately upstream of the confluence with the Yukon River, and downstream of the open pits in this catchment. Note that this model node location is the same as water quality monitoring location ML-01.
- YRdsYT24 – Yukon River, immediately downstream of YT24 confluence.
- HC-2.5 – Halfway Creek, roughly mid-drainage. Downstream of the principle points of discharge from the Alpha WRSF and Kona Pit sub-watershed models.
- HC-5.0 – Halfway Creek immediately upstream of the Halfway Creek-Yukon River confluence. Project-affected discharges reporting to HC-2.5 will become more dilute as they approach HC-5.0.
- YRdsHC50 – Yukon River, immediately downstream of Halfway Creek confluence.

The surface water quality assessment focuses on key locations within the main catchments (**Figure 2.2-2**) where the magnitude of potential Project effects is considered to have the greatest influence on the receiving environment. The selected locations for discussion in this section include the following: CC-1.5, CC-3.5, CC-4.5, YT-24, HC-2.5, HC-5.0, YRdsYT24 and YRdsHC-5.0.



COFFEE GOLD MINE

Mine Site General Arrangement, Project Catchment Areas and Water Quality Model Nodes (End of Year 9)

Figure 2.2-1	Date: Mar 24, 2017	Drawn by: GM	Reviewed: AS

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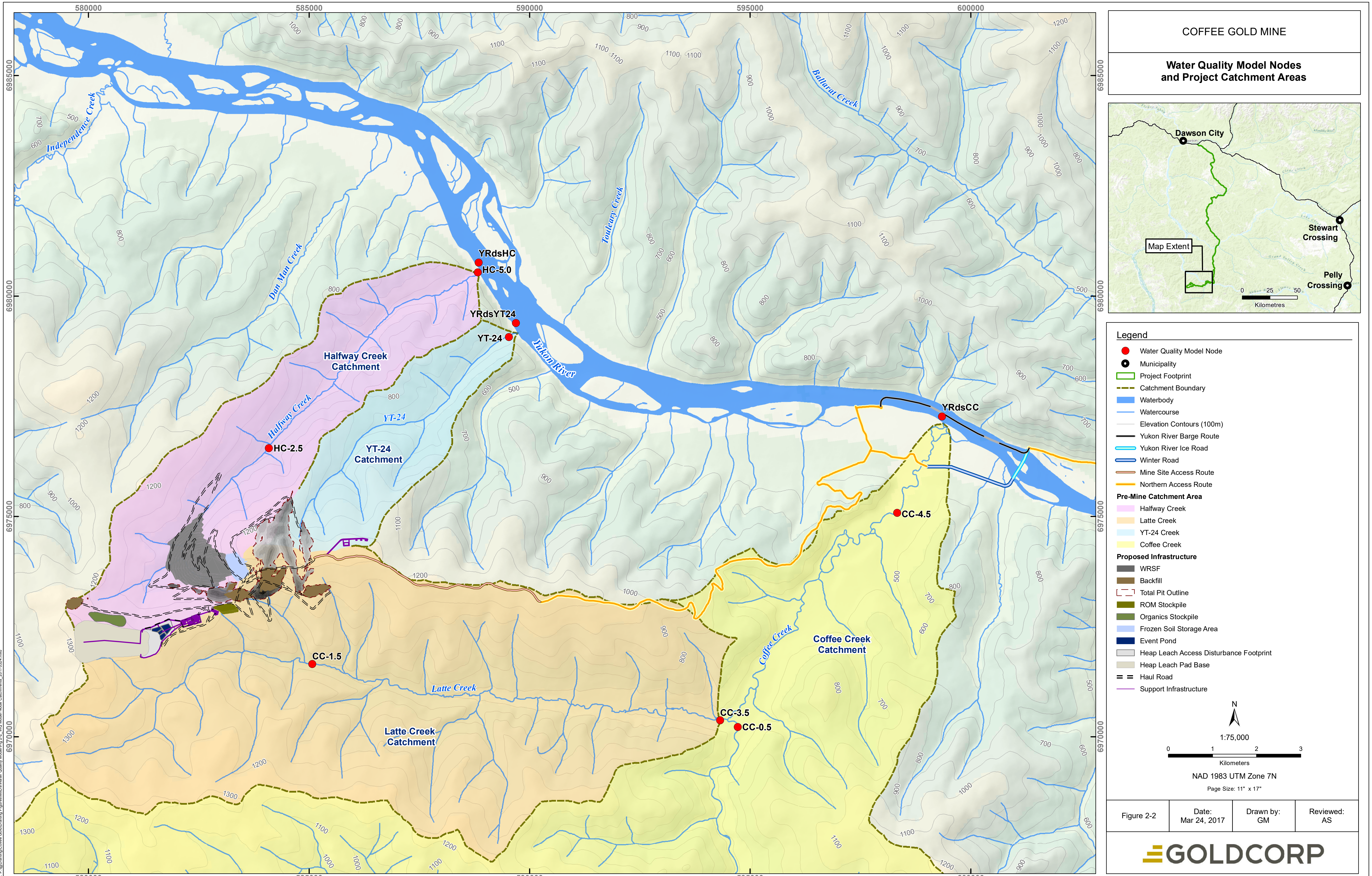
COFFEE GOLD MINE
Water Quality Model Nodes
and Project Catchment Areas
Dawson City
Stewart Crossing
Pelly Crossing
Map Extent
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Water Quality Model Node
Municipality
Project Footprint
Catchment Boundary
Waterbody
Watercourse
Elevation Contours (100m)
Yukon River Barge Route
Yukon River Ice Road
Winter Road
Mine Site Access Route
Northern Access Route
Pre-Mine Catchment Area
Halfway Creek
Latte Creek
YT-24 Creek
Coffee Creek
Proposed Infrastructure
WRSF
Backfill
Total Pit Outline
ROM Stockpile
Organics Stockpile
Frozen Soil Storage Area
Event Pond
Heap Leach Access Disturbance Footprint
Heap Leach Pad Base
Haul Road
Support Infrastructure
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Yukon River
Independence Creek
Dan Man Creek
Toulouse Creek
Ballarat Creek
Halfway Creek
YT-24
Latte Creek
Coffee Creek
Halfway Creek Catchment
YT-24 Catchment
Latte Creek Catchment
Coffee Creek Catchment
YRdsHC
HC-5.0
YRdsYT24
YT-24
HC-2.5
CC-1.5
CC-3.5
CC-0.5
CC-4.5
YRdsCC

2.2.2 WATER BALANCE MODEL

The WBM is a detailed interpretation of the mine and water management plans, with consideration of baseline climate, hydrometric, and hydrogeological data collected for the Project. The WBM was developed in GoldSim and is the foundation upon which the WBM has been developed, in the sense that water quality is assigned to each flow condition included in the water balance model. The following section provides a general overview of the model, whereas a full description of the inputs and assumptions employed in the model is provided in Appendix 12-C and Appendix 12-D.

The WBM considers the mine plan and all associated major Project footprints (e.g., year by year progressions of open pit development) and incorporates water management plans and mitigation measures (e.g., pit dewatering, diversions). It is used to derive predicted flows from the Construction through the Post-closure phases.

In addition to the surface water quality monitoring dataset, the WBM is strongly informed by hydrological and climatological monitoring data and modelling exercises, which included the following inputs (refer to Appendix 8-A of the Project Proposal):

- Two to five years of baseline streamflow data (11 stations)
- Four years of site climate record
- Reconstructed site climate record (28 years in length) and daily discharge records (33 years in length), and
- Regional climate change analyses to inform closure water balance scenarios.

The WBM is configured to represent all relevant physical processes at the Project site that drive streamflow and water quality, which are closely linked. Surface runoff, baseflow, creek ice formation, and snowfall/melt processes are represented, as are the elevational dependence of the temperature and precipitation inputs. Potential evapotranspiration (PET) is included as a function of daily mean temperature, plus a stochastic adjustment to represent the observed variability of PET at the site. The current configuration of the site-wide water balance predicts flows at the ten receiving environment nodes (described above in **Section 2.2.1**), accounting for variability based on a 28-year synthetic climate record and the effect of climate change on air temperature and precipitation. The synthetic climate record has been developed based on regional streamflow and climate data, and is described in detail in Appendix 12-C.

Predicted flows for each model node employed a background component calculated from baseline monitoring data. For creek model nodes, flows were calibrated against the baseline monitoring dataset. This approach is described in further detail in Appendix 12-C.

With respect to the Yukon River, the WBM assumes flow from Coffee Creek, YT-24 and Halfway Creek to the Yukon River is partially mixed at each respective model node. Given the measurable dilution afforded by the Yukon River relative to Project area creeks, this approach yielded a conservative estimate of potential water quality in creek mixing zones within the Yukon River. The WBM therefore assumes water discharging from each creek into the Yukon River mixes with only 2% of the Yukon River flow at the modelled downstream locations. Full mixing is assumed to occur in the Yukon River between stations YRdsCC and YRdsYT-24, and partial mixing (25%) inferred between stations YRdsYT-24 and YRdsHC.

2.2.3 Source Terms

The source terms input to the WBM incorporate site-specific baseline surface and groundwater water quality data sets, static and kinetic geochemical data sets, and mine-specific outputs. The following sections summarize the approach taken for developing inputs to the WBM.

2.2.3.1 Background Water Quality

The background surface water quality terms incorporate contributions from surface and groundwater sources using baseline data sets (Appendix 12-A: Surface Water Quality Baseline Study Report and Appendix 7-A: Hydrogeology Baseline Study Report of the Project Proposal). For all model nodes except those in the Yukon River, assumed background flows and water quality were calibrated against the baseline monitoring datasets to generate results for a Natural Case (i.e., no Project influence), allowing for direct comparison between water quality predictions and expected background levels taking climate considerations into account.

The background water quality assumed for model nodes within the Yukon River is based on monthly mean background terms calculated directly from the YUK-2.0 baseline monitoring dataset (Appendix 12-A; summarized in **Section 2.3.3**), combined with Natural Case water quality from the tributaries flowing into the Yukon River. It should be noted that the background terms for Yukon River stations does not take inter-annual climate variability within the Yukon River into account.

Assumptions used to integrate background water quality components into the WBM are described in further detail in Appendix 12-C (Water Quality and Water Balance Model Report) of the Project Proposal.

2.2.3.2 Geochemical Source Terms

Geochemical source terms have been developed for the major mine components, taking into account mine-related activities throughout the Construction, Operations, Reclamation and Closure and Post-closure phases. The source terms are based on site-specific static and kinetic geochemical test results, as well as data from analogue sites. The approach and assumptions used to develop the geochemical source terms are discussed in detail in Appendix 12-D. A summary of the approach applied to the different mine components is outlined below:

- Waste rock storage facilities: the source terms associated with the Project's waste rock facilities are based on lithology-specific field bin results which have been scaled up based on physical scaling factors and data from waste rock pile data from an analogue site with similar geochemical and weathering characteristics (the former Mount Nansen mine located west of Carmacks). The predicted loading rates are combined with the flow data and incorporated into the WBM.

- Pits: source terms have been developed for loads associated with the pitwalls and the backfilled waste rock placed in the pits. The pitwall loading rates are determined by scaling lithology-specific humidity cell loading rates, taking site-specific conditions into account. The backfilled waste rock terms are developed following the same approach outlined for waste rock piles.
- Heap Leach Facility: source terms have been developed for the rinsing and detoxification phase of the Project when the leachate will report to the treatment facility prior to discharge, as well as for the Post-closure time period when residual loads will report directly to the receiving environment. The loads associated with different ore material during Operations are assessed based on leachate collected from metallurgical test columns. The treated effluent concentrations are based on benchscale testwork using site-specific ore. The estimated drainage from the facility following the treatment period is based on kinetic testing conducted on leach tailings samples produced from metallurgical testwork.
- Stockpiles: A source term has been developed to account for loads associated with the temporary organics stockpile placed in the plant site area that is based on the results of shake flask extraction data from site specific materials. The model does not account for any additional loads associated with soil salvage stockpiles since these loads are expected to be insignificant. An ore stockpile source term has been developed based on humidity cell results, but because the drainage will be captured by the HLF drainage collection system, these terms are not reflected in the WBM output.
- Blasting residues: source terms have been developed to quantify nitrogen (N) loads resulting from the use of nitrogen-based explosives. The residues associated with blasted waste rock are calculated as a function of annual project schedules for waste rock deposition and explosives consumption, as per an Environment Canada study (Ferguson and Leask, 1988). Concentrations of N in waste rock leachate were calculated as a function of mean annual precipitation and normalized to leachate data from analogue mine sites in northern environments. Nitrogen loadings at the Project site were assumed to decline based on observations from large-scale instrumented waste rock lysimeters at the Diavik Mine (Bailey et al, 2013) and were normalized to local mean annual precipitation. The loads are assumed to decrease at a constant decay rate of 14% through to the end of the modelled Post-closure phase and until they reach background levels. A detailed description of the methods used to derive the N source terms for different Project components is provided in Appendix E.1 of Appendix 12-D, the Geochemical Characterization Report, and includes the equations as well as the complete set of calculated N source terms.
- Sewage Treatment Plant (STP): It is assumed that wastewater from the camp will be treated and used in the HLF. Consequently, the STP discharge is excluded from the model.

2.2.4 Model Sensitivities

Water quality predictions throughout Construction, Operations, Reclamation Closure and Post-closure phases were generated for a Base Case as well as various model sensitivity cases. The Base Case incorporates expected geochemical source terms from mine-related inputs, expected flow conditions and conservative assumptions for climate change. For the purpose of the surface water quality effects assessment, the Base Case is considered to represent a robust expected case and, as such, is used as the basis to predict Project-related effects to surface water quality.

Additional water quality model cases were run, including an Upper Case scenario to evaluate variable flow conditions, captured in the 28 different climate realizations, and an Upper Geochemistry Case to evaluate the sensitivity of the model to upper case geochemical source terms. Further details on assumptions employed for each sensitivity is presented in Appendix 12-C.

The Upper Case water quality predictions are based on the same model output as the Base Case scenario, incorporating base case geochemical source terms, but are calculated from the 95th percentile values of the model output generated from 28 different climate realizations (rather than the mean). For this reason, Upper Case predictions may reflect prolonged wet or dry events captured within the model's 28-year baseline climate record (refer to Appendix 12-C for further detail), in some cases resulting in higher monthly predictions relative to the corresponding Base Case.

The Upper Geochemistry Case incorporates upper case geochemical source terms for all mine-related inputs, expected Base Case flow conditions and conservative assumptions regarding climate change. In this model scenario, potential upper-limit effects to water quality from geochemical sources (e.g., leaching/weathering of disturbed mining materials and wastes) are predicted.

2.2.5 Limitations and Assumptions

The water quality predictions developed for the Project are subject to certain limitations and assumptions related to the design of the Project and the site-specific data sets available. The main limitations and assumptions of the model are highlighted below:

- Water will be managed according to the Project's Water Management Plan (Appendix 31-E); Non-contact water is diverted around pits and WRSFs where possible; it is assumed that there is no leakage from collection ditches.
- The sedimentation ponds and sumps will receive both contact flow and non-contact water and will function as designed; they will be effective in eliminating total suspended solids (TSS) and particulate-associated elements to levels specified in MMER and other applicable standards, prior to discharge.
- The Facility Pond is allowed to fill according to the water balance flows and pond volumes and discharge accordingly (e.g., no managed flow). The Alpha Pond is pumped out at a rate of 300 L/s from May to September.
- For all pits except Kona pit, precipitation runoff associated with pit walls collects within the pit and is pumped to the downstream receiver stream during the Operations phase. All Kona pit water is directed to the HLF for make-up water, and Latte pit water is used as HLF makeup water as required. Once the pit lakes reach their spill elevation, they are assumed to spill passively to the receiving streams.
- It is assumed that contact water is not used for dust suppression at the mine site.

- Mine facilities will be developed according to the development schedules and timelines set out in the mine plan, as described in Section 2.0 Project Description, and will include design mitigation components like phased mine development and progressive reclamation.
- The water treatment plant will treat contact water from the HLF as specified below:
  - Discharge of treated water will begin in the towards the end of the Operation (Year 9), at a rate of 2 L/s in April, and 4 L/s for May through September during Operations. Immediately after the cessation of ore stacking, treatment rates ramp up to 5 L/s for April and 11 L/s for May through September for an additional 3 to 4 years, as dictated by the Operation and Drain-down heap leach water balance models (see Appendix 1 and 2 within Appendix 12-C).
  - Effluent quality from the water treatment plant are based on bench scale test results of metallurgical heap leach solutions.
  - Treatment and discharge are assumed to only occur during the six-month open-water period.
  - It is assumed that treatment will no longer be required by Year 20, at which point discharge from the detoxified HLF will be directed to the Alpha WRSF underdrain at flow rates dictated by variable meteoric inputs.
- A portion of water collected in certain pits (e.g., Latte, SU1, SU2, SU4N and SU4S) is expected to leak via groundwater pathways:
  - Leakage was determined based on elevation-dependent flows (Appendix 7-B-1) and the predicted water quality in the respective pits.
  - It is assumed that leakage reports instantaneously to the receiving environment, at the closest model node.
- The GoldSim WBM employs a mass balance approach and does not explicitly account for geochemical or microbially-mediated reactions that are likely to occur in the surface receiving environment; however, it is assumed that a 75 percent load reduction is applied to species subject to reductive attenuation in anaerobic groundwater environments (e.g., NO_2, NO_3, WADCN) and species where natural attenuation in the groundwater environment has been observed (Sb and As). All other parameters are treated conservatively.

2.3 Screening Approach

The Base Case model predictions form the basis for this assessment, whereby concentrations of individual parameters are screened against relevant water quality guidelines for the protection of aquatic life. The surface water quality parameters exceeding the specified guidelines are carried forward into the residual effects assessment.

The screening approach applied to predicted water quality results for the Project is based on the most sensitive designated water use in the Project area: freshwater aquatic life. Sensitive uses identified in TK, stakeholder consultation, baseline studies, and scientific information, include drinking water, aquatic life, wildlife and livestock watering, irrigation, and aesthetic and recreational uses (refer to Section 3.0 and section 5.0 of the Project Proposal for further information on consultation and valued component selection, respectively). Notably, much significance is attributed to Coffee Creek in TK as a travel corridor and temporary camp site (e.g., Tr'ondëk Hwëch'in 2012; Easton *et al*., 2013; Yukon River Commercial Fishing Association & Tr'ondëk Hwëch'in, 1997). However, water quality guidelines for the protection of freshwater aquatic life are lower than guidelines approved for other water uses listed above, including Health Canada drinking water standards.

Water quality predictions at the key WBM model nodes are therefore compared to Canadian Council of Ministers of the Environment (CCME) or BC aquatic life water quality guidelines (WQGs), or equivalent screening tools (e.g., CCME trophic trigger ranges in the case of phosphorus) as part of the assessment methodology (**Table 2.3-1**). Parameters predicted to exceed WQGs or trigger ranges are further considered in the context of the residual effects assessment.

Table 2.3-1 Proposed Water Quality Objectives for the Assessment of Surface Water Quality

Parameter	Unit	Regulatory Source for Guideline	Proposed Water Quality Objectives				
			Latte Creek	YT-24	Halfway Creek	Coffee Creek (CC-4.5)[a]	Yukon River (YUK-5.0)[a]
NH_3-N	mg/L	BC	1.63[b]	1.91[b]	1.91[b]	0.04	0.03
NO_2-N	mg/L	BC	0.02[c]	0.02[c]	0.02[c]	0.05	0.05
NO_3-N	mg/L	BC	3	3	3	0.6	0.2
P	mg/L	CCME	0.1[d]	0.1[d]	0.1[d]	–	–
SO_4	mg/L	BC	309[e]	218[e]	218[e]	77	25
WAD-CN	mg/L	BC	0.005	0.005	0.005	Non-detectable	Non-detectable
Total Metals and Metalloids							
Ag	mg/L	CCME	0.00025[e]	0.00025[e]	0.00025[e]	0.000007	0.00002
As	mg/L	CCME	0.005	0.005	0.005	0.0006	0.0013
Cd	mg/L	CCME	0.00013[e]	0.0001[e]	0.00011[e]	0.00005	0.00021
Cr	mg/L	CCME	0.001[f]	0.001[f]	0.001[f]	–	–
Cu	mg/L	CCME	**0.003**	**0.0034**	**0.003**	0.0042[g]	0.0055[g]
Fe	mg/L	CCME	1	1	1	0.349	2.066[g]
Hg	mg/L	CCME	0.000026	0.000026	0.000026	0.00001	0.00001
Mn	mg/L	BC	0.89[e]	0.97[e]	0.86[e]	–	–
Mo	mg/L	CCME	0.073	0.073	0.073	0.00074	0.0013
Ni	mg/L	CCME	0.082[e]	0.061[e]	0.069[e]	0.0015	0.0046
Pb	mg/L	CCME	0.0025[e]	0.0015[e]	0.0018[e]	0.00021	0.0011
Sb	mg/L	BC	0.009	0.009	0.009	0.00014	0.0002
Se	mg/L	BC	0.002	0.002	0.002	0.0001	0.00056
Tl	mg/L	BC	0.0008	0.0008	0.0008	–	–
U	mg/L	CCME	**0.031**	0.015	**0.086**	0.0036	0.001
Zn	mg/L	CCME (draft)	0.015[e]	0.011[e]	0.013[e]	0.0052	0.0017[g]

Parameter	Unit	Regulatory Source for Guideline	Proposed Water Quality Objectives				
			Latte Creek	YT-24	Halfway Creek	Coffee Creek (CC-4.5)[a]	Yukon River (YUK-5.0)[a]
Dissolved Metals and Metalloids							
Ag	mg/L	–	–	–	–	0.000005	0.000005
Al	mg/L	BC	**0.351**	**0.205**	**0.403**	0.263[g]	0.045
As	mg/L	–	–	–	–	0.00049	0.00054
Cd	mg/L	–	–	–	–	0.000031	0.00006
Cu	mg/L	–	–	–	–	0.0033	0.0017
Fe	mg/L	BC	0.35	0.35	0.35	0.203	0.059
Hg	mg/L	–	–	–	–	0.00001	0.00001
Mo	mg/L	–	–	–	–	0.00068	0.00125
Ni	mg/L	–	–	–	–	0.0013	0.0017
Pb	mg/L	–	–	–	–	0.000055	0.00006
Sb	mg/L	–	–	–	–	0.00012	0.00012
Se	mg/L	–	–	–	–	0.00012	0.0005
U	mg/L	–	–	–	–	0.0038	0.001
Zn	mg/L	–	–	–	–	0.0022	0.0028

Notes:

CCME = Canadian Council of Ministers of the Environment (CCME 2014); BC = British Columbia Ministry of Environment (B.C MOE 2015a,b); dash (–) indicates not proposed.

Values in bold font represent Proposed Site Specific Water Quality Objective (SSWQO). Other values are either based on the generic water quality guidelines (BC or CCME) or non-degradation objectives.

a. Non-degradation objective; all values calculated as 90th percentile of corresponding baseline dataset unless otherwise noted.

b. Guidelines calculated using assumed temperature of 7°C and 25th percentile pH from corresponding baseline dataset.

c. Chloride dependent; value shown assumes Cl > 2 mg/L.

d. Proposed seasonal limit based on CCME trophic trigger range; applied during months of open water (April to October).

e. Hardness-dependent; values shown assume 25th percentile hardness from corresponding baseline dataset.

f. CCME water quality guideline for Cr(VI).

g. 95th percentile from baseline dataset.

CCME WQGs were used as the default standards against which predictions were screened, unless the BC WQG for the corresponding parameter was more appropriate. For certain parameters, like antimony or sulphate, CCME WQGs for aquatic life have not been approved so the corresponding approved BC WQGs for these parameters were adopted. For other parameters, like aluminum, both BC and CCME WQGs exist but the BC WQG was considered more appropriate for Project site conditions. In the case of aluminum, the BC guideline is based on the dissolved metal fraction in the water column while the CCME guideline is based on the total fraction; baseline monitoring in Project area creeks shows the bulk of measured aluminum occurs in the dissolved form. Therefore, the BC WQG (for dissolved aluminum) was used to screen predicted water quality. A detailed description of the rationale for each guideline by parameter is presented in **Appendix 12-C-4**.

Long-term, instead of short-term, guidelines were used for parameters for which both kinds of guideline are approved. Long-term (i.e., “chronic”) WQGs are intended to protect against adverse effects during indefinite exposures. Short-term WQGs are set to protect against acute adverse effects, such as lethality over a defined short-term exposure period (e.g., 96 hours). Because the WBM runs on a monthly time-step, representing a chronic exposure period, long-term guidelines were preferentially used to evaluate model predictions.

Hardness-dependent or pH-dependent WQGs (as indicated by notes d and e in **Table 2.3-1**, respectively) were calculated using the 25th percentile levels from the baseline water quality dataset for each station. Water quality guidelines shown for reference in **Table 2.3-1** assume a water hardness equal to the 25th percentile of the corresponding station’s baseline dataset; other assumptions used to calculate guidelines are presented in the table footnotes. Further detail on the rationale for the derivation of each guideline is provided in **Appendix 12-C-4**.

To evaluate total phosphorus (T-P), CCME (2004) trigger ranges for Canadian lakes and rivers were used to identify changes in predicted T-P levels that could alter the trophic status of Project creeks. Potential effects from elevated T-P will generally relate to system eutrophication rather that toxicity. Therefore, CCME (2004) outlines a tiered approach to evaluating phosphorus effects to water bodies by relating their trophic status to predefined ‘trigger ranges’ (measured as total phosphorus concentration; **Table 2.3-2**). An increase to T-P levels in a water body that corresponds to a change in trophic status may indicate that there is a risk of an effect to that system. For the purposes of the present assessment, T-P trigger ranges for each model station were established based on the highest monthly 95th percentile level for months of open-water (i.e., April through October) in the corresponding baseline water quality dataset. The upper limit value for the corresponding trigger range was used as the water quality objective to screen modelling predictions. This approach was used to account for natural fluctuations in T-P associated with spring freshet and high flow events in Project area creeks, and is described in further detail **Appendix 12-C-4**.

Table 2.3-2 CCME Total Phosphorus Trigger Ranges for Canadian Lakes and Rivers

Trophic Status	Trigger Ranges for Total Phosphorus (ug/L)
Ultra-oligotrophic	< 4
Oligotrophic	4 - 10
Mesotrophic	10 - 20
Meso-eutrophic	20 - 35
Eutrophic	35 - 100
Hyper-eutrophic	> 100

Source: CCME 2004

2.4 RESIDUAL EFFECTS IDENTIFICATION AND CHARACTERIZATION

The methods used to identify, characterize and assess residual effects were developed pursuant to assessment requirements set out in the *Yukon Environmental and Socio-economic Assessment Act* (YESAA).

In order to identify which of the parameters exceeding the relevant guidelines are carried forward to the residual effects assessment, the surface water quality results at each model node were first compared to the background condition (i.e., the Natural Case) to distinguish potential Project-related effects to surface water quality.

Where appropriate, surface water quality predictions were compared to proposed site-specific water quality objectives (PSSWQOs). Proposed site-specific water quality objectives were calculated for parameters that naturally exceed WQGs at CC-1.5, CC-4.5 and HC-2.5 (dissolved aluminum, total copper, total iron, total uranium) following the Background Concentration Procedure outlined in CCME (2003). In this approach, the existing WQG is lower than the natural background concentration of these parameters making it necessary to generate revised objectives (i.e., PSSWQOs) to account for natural guideline exceedances in the Project area. Following guidance in CCME (2003) and BC MOE (2013, which prescribes updated recommendations for site-specific benchmarks), PSSWQOs were set equal to the 95th percentile concentration of that parameter's baseline dataset from the corresponding station. Further detail on the rationale for the specified WQGs and PSSWQOs is provided in **Appendix 12-C-4**.

Predicted residual effects to surface water quality have been assessed for potential parameters of concern (those indicators exceeding their respective guideline, and whose concentration cannot be attributed to background levels) at each of the relevant receiving environment model nodes (**Section** Error! Reference source not found.). Effects were characterized according to standard criteria including direction, magnitude, geographic extent, timing, frequency, duration, reversibility and probability of occurrence, followed by the determination of residual effect significance and level of confidence.

3.0 EXISTING CONDITIONS

The information in this section establishes the context for the assessment of effects to surface water quality from the Project, by presenting information relevant to the pre-Project or baseline condition (i.e., conditions prior to interaction with the Project), in both the LAA and RAA. In **Section 3.1**, the regulatory context of the surface water quality assessment is presented, with consideration of relevant regulatory and legislative components that will guide the Project assessment and licensing processes. This is followed by a summary of background information and studies (**Section 3.2**), including TK pertaining to the Project area and resources (**Section 3.2.1**), scientific and other information relied upon to inform the baseline characterization of the Project area (**Section 3.2.2**), and a summary of baseline studies conducted during the Project's feasibility program. Finally, **Section 3.3** presents a summary of existing conditions for surface water quality in the Project area.

3.1 REGULATORY CONTEXT

The management, use and discharge of water from a mine site is governed by several pieces of federal and territorial legislation. This section provides an overview of the relevant federal and territorial statutory framework, guidance documents, and policies related to potential Project-related surface water quality effects (summarized in **Table 3.1-1**).

At the federal level, the discharge of mine effluent is governed under the *Fisheries Act*, and specifically by the Metal Mining Effluent Regulations (R.S.C. 1985, c.F-14) (**Table 3.1-1**). The latter imposes limits on the discharge of deleterious substances for any mine that exceeds a discharge rate of 50 m^3/day (from all final discharge points). The *Canada Water Act* (R.S.C 1985, c. C-11) provides legislation for the management of water resources in Canada and between federal and provincial agencies.

The primary territorial Acts are the *Quartz Mining Act* (SY 2003, c. 14) and the *Waters Act* (SY 2003, c. 19) (**Table 3.1-1**). The application information requirements for licenses under these acts overlap substantially, and the regulation of mining activities is integrated across all environmental disciplines. Thus, the effects assessment for the surface water quality VC must take these regulatory requirements into account, through the mine plan, water management plans (including discharge of effluent), and operational monitoring and reporting plans. As an extension, some of the mitigation measures proposed to offset an effect to this VC will be informed by the regulatory requirements.

Several guidance documents informed the Project assessment process. The Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BC MOE, 2012) guides mine proponents in study design for baseline monitoring, while the *Plan Requirement Guidance for Quartz Mining Projects* (Yukon Water Board, 2013) outlines environmental protection plans and operational plans for the development, operation, and decommissioning of a mine site. Finally, the characterization and assessment of potential effects to water quality parameters was determined through comparison against CCME (2014) and BC working and approved WQGs (2015a,b) for the protection of aquatic life.

Table 3.1-1 Summary of Applicable Legislation and Regulatory Frameworks for Surface Water Quality, Coffee Gold Project

Federal Acts and Regulations	Citation	Rationale
Canada Water Act	R.S.C 1985, c. C-11	Establishes national management of water resources, including consultation, policy-formulation, and program implementation. Provides for the sustainability and ongoing productivity of commercial, recreational, and Aboriginal fisheries. Regulates activities that may affect fish or fish habitat, including modification of flows, alteration or destruction of habitat, and deposition of deleterious substances.
Fisheries Act • Metal Mining Effluent Regulations (SOR/2002-222)	R.S.C. 1985, c.F-14	Provides the framework for the joint federal-provincial management of Canada's water resources, including discharge of wastes into water, including groundwater. Establishes effluent quality criteria for metal mining projects, and monitoring requirements for environmental effects.
Canadian Environmental Protection Act, 1999 Environmental Emergency Regulations (SOR/2003-307) Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2002-301)	S.C. 1999 c. 33	Regulations defining hazardous wastes, and how and where they are stored and transported. Sets out requirements for transport manifests and emergency plans. Sets out requirements for size, operation and maintenance of storage tank systems, as well as requirements for leak detection and release reports.
Territorial Acts and Regulations	**Citation**	**Rationale**
Public Health and Safety Act Camp Sanitation (CO 1961/38) Drinking Water Regulation (OIC 2007/139) Sewage Disposal Systems Regulation (OIC 1999/82)	RSY 2002 c. 176	Provides legal framework for protection of public health. Stipulates camp drainage must be arranged to prevent pollution of any water supply, lake, stream or watercourse. Regulates location, testing and general assessment of drinking water systems including those derived from groundwater. Regulates discharge of sewage.
Environment Act Contaminated Sites Regulation (O.I.C. 2002/171)	RSY 2002 c.76	Defines contaminated sites (which may include surface water quality components), stipulates contaminated site restoration or rehabilitation and sets forth generic numerical soil and water standards. Legislates reporting of spills and protection orders related to spills.
Quartz Mining Act • Quartz Mining Land Use Regulation (OIC 2003/64) • Quartz Mining Fees and Forms Regulation (OIC 2009/28)	SY 2003, c. 14	Establishes regulation for the application, development, and operation of exploration and mining programs in Yukon. Producing hard-rock mining projects in Yukon are licensed under the *Quartz Mining Act* and the *Waters Act* (below), as per regulation shown.
Waters Act • Waters Regulation (OIC 2003/58)	SY 2003, c. 19	*Waters Act* establishes the Yukon Water Board, issuer of water use licenses that ensure that appurtenant uses of water or deposits of waste do not adversely affect other users. Waters Regulation defines water management areas, classification of undertakings and licensing criteria for mines.

Guidance Documents	Citation	Rationale
Plan Requirement Guidance for Quartz Mining Projects	Yukon Water Board 2013	Outlines environmental and operational information requirements for plans submitted in accordance with Quartz Mine License and Water License processes.
Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators	BC MOE 2012	Outlines baseline monitoring and recommendations for mining projects
Canadian Council of Ministers of the Environment (CCME) • Canadian Water Quality Guidelines for Protection of Aquatic Life	CCME 2014	Presents national water quality guidelines for various parameters that are protective of aquatic biota and habitat
British Columbia Approved and Working Water Quality Guidelines	BC MOE 2015a, b	Presents provincial water quality guidelines for BC for various parameters that are protective of aquatic biota and habitat

3.2 Background Information and Studies

3.2.1 Traditional Knowledge

The purpose of this section is to describe how TK informed the assessment. The scoping of the assessment, including issues scoping, selection of VCs and indicators, and characterization of assessment boundaries, were informed by TK related to surface water quality as a VC. Information was obtained from a TK database containing passages and quotations from First Nations and communities, with information on site-specific use and values within the regional and local assessment areas.

The TK database was populated from existing literature, alongside information gained through an engagement and consultation process with affected First Nations and communities, as defined under section 50 (3) of the YESAA. This information was used to support the scoping of issues for the Project (refer to Sections 3.0 through 3.6 of the Project Proposal for detail on the consultation program), in addition to VC-specific parameter scoping.

The scoping assessment was informed by detailed information and direct accounts of TK from the following representative First Nations:

- Tr’ondëk Hwëch’in
- Selkirk First Nation
- First Nation of Na-cho Nyäk Dun, and
- White River First Nation.

3.2.2 SCIENTIFIC AND OTHER INFORMATION

The purpose of this section is to demonstrate how existing scientific and other information informed the assessment. The assessment of potential effects to surface water quality was informed by change analyses developed for linked ICs, most notably the groundwater analysis (Appendix 7-B of the Project Proposal), and the surface hydrology analysis (Appendix 8-B of the Project Proposal). The change analyses for other ICs or VCs linked to surface water quality (i.e., air quality and greenhouse gas emissions (Appendix 9-B of the Project Proposal), and surficial geology, terrain and soils (Appendix 11-B of the Project Proposal)) were considered qualitatively.

The surface water quality assessment is further informed by scientific datasets used in the development of the WBM, which is used to predict surface water quality through the Project life (summarized in **Section 2.2** of this report). This model was informed by several surface hydrology data sources, including multi-year climate and streamflow regional datasets, peer-reviewed literature, and government guidance documents. These information sources are described in further detail in Project Proposal Appendix 8-B.

Examples of peer-reviewed literature and government guidance documents that were relied upon to inform the surface water quality baseline and assessment process include:

- Baseline water quality sampling, data collection and analysis, as described in the British Columbia Field Sampling Manual (BCMOE 2013)
- Derivation of site specific water quality objectives, as described in Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives (CCME, 2003; further detail on site specific water quality objectives is presented in **Appendix 12-C-4**), and
- Several technical journal articles from the scientific literature to support the derivation of proposed site specific water quality objectives. Articles are presented in detail in **Appendix 12-C-4**.

3.2.3 BASELINE STUDIES CONDUCTED DURING THE PROJECT'S FEASIBILITY PROGRAM

A multi-year baseline water quality monitoring program was undertaken in the LAA and RAA in order to characterize pre-Project conditions. The program included all of the drainages potentially affected by the Project:

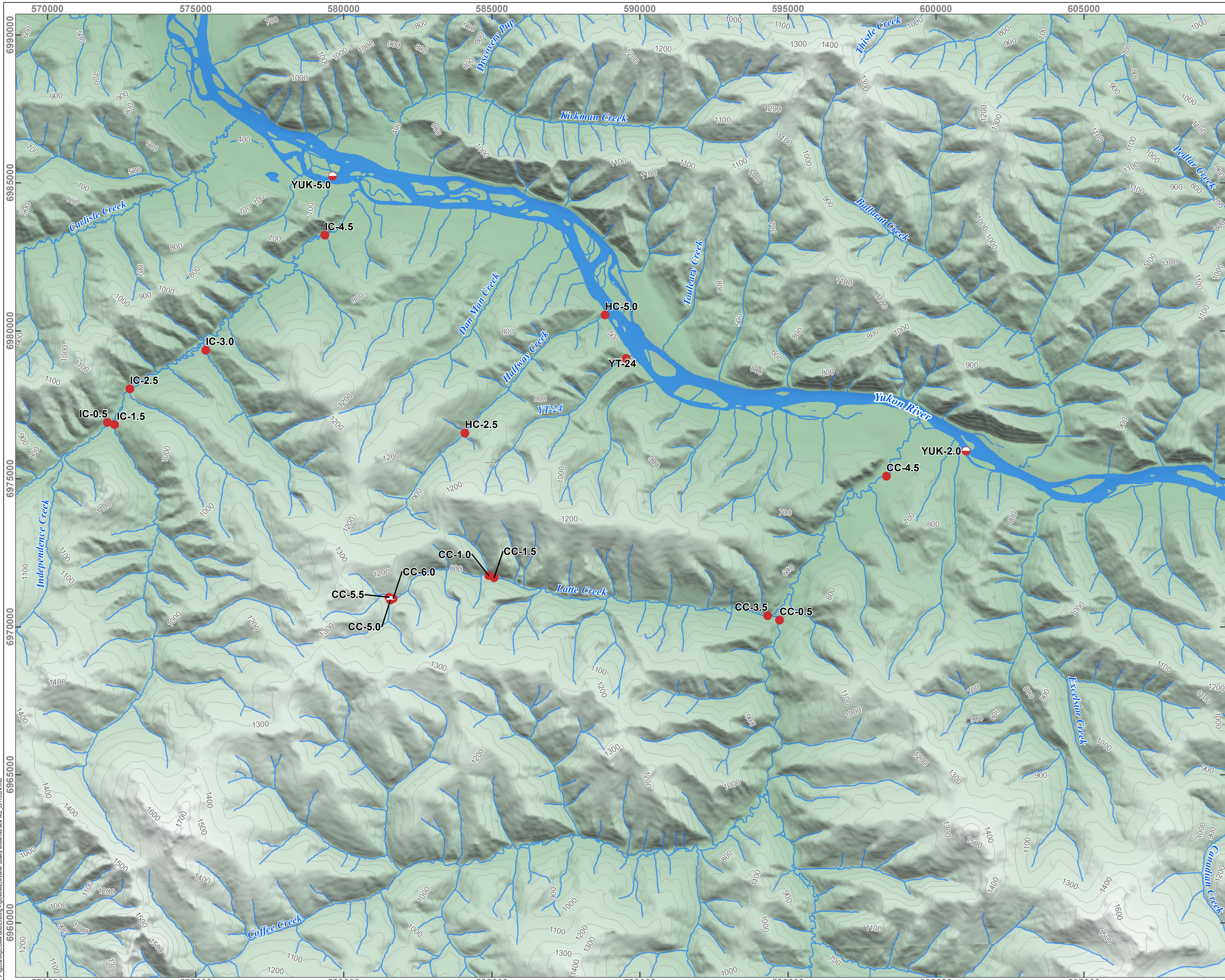
- Latte Creek
- Coffee Creek
- YT-24
- Halfway Creek, and
- Yukon River.

In addition, Independence Creek was included in the surface water quality monitoring program as a reference site. This catchment drains to the Yukon River approximately 12 km downstream of the Coffee Creek confluence, and will not receive discharges from any mine components. The Coffee Gold Project Baseline Water Quality Report presents a detailed summary of the baseline surface water quality monitoring program and is included in Appendix 12-A.

A total of 18 water quality stations were established as part of the baseline water quality program. The locations of these stations are shown in **Figure 3.2-1**, and station coordinates; station type (e.g., reference or potential exposure), the date that monthly sampling began, and the rationale for including stations are provided in **Table 3.2-1**. Stations are typically sampled on a monthly basis, although certain sites were not sampled during winter months if the watercourse was frozen or if the stream bed was dry.

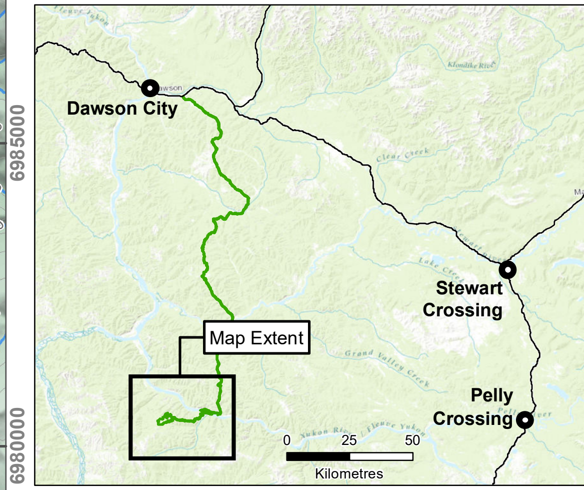
Table 3.2-1 Summary of Desktop and Field Studies Related to Surface Water Quality

Study Name	Study Purpose, Duration and Spatial Boundaries
Coffee Gold Project Baseline Water Quality Monitoring Program (2010 – Present)	The purpose of this program was to provide a detailed characterization of pre-Project conditions in the Mine Site area. This information will be used to support the definition of environmental benchmarks against which potential Project effects may be measured. The spatial boundaries of this program overlapped with the Project LAA and RAA, including surface water quality monitoring stations in Latte Creek, Coffee Creek, YT-24, Halfway Creek, Independence Creek, and the Yukon River. Baseline monitoring was initiated on a monthly basis, as conditions allowed, on the following dates: • Latte Creek - October 2010 • Coffee Creek - October 2010 • YT-24 – June 2014 • Halfway Creek - October 2010 • Independence Creek - October 2010 • Yukon River - October 2010



COFFEE GOLD MINE

Surface Water Quality Monitoring Stations



Legend

- Surface WQ Monitoring Stations
- Surface and Hydrology Monitoring Stations
- Municipality
- Highway
- Project Footprint
- Watercourse
- Waterbody

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NAD 1983 UTM Zone 7N

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Figure 3.2-1	Date: Mar 24, 2017	Drawn by: GM	Reviewed: CF

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Table 3.2-2 Water Quality Sampling Stations, Coordinates, and Rationale

Site	Drainage	Coordinates		Site	Sampling	Rationale
		North	East	Type	Start Date	
Latte Creek						
CC-6.0	Upper Latte Creek	6971061	581317	Potential exposure	June-2014	To assess effects of mine effluent from HLF
CC-5.5	Small tributary from northwest to upper Latte Creek	6971100	581061	Potential exposure	June-2014	
CC-5.0	Small tributary from south to upper Latte Creek	6970905	581079	Potential exposure	June-2014	Latte Creek background
CC-1.0	Small tributary to Latte Creek draining part of mine site	6971733	584890	Exposure	June-2014	To assess effects of mine effluent in Latte Creek
CC-1.5	Latte Creek downstream of CC-1.0 drainage	6971654	585071	Exposure	Oct-2010	To assess effects of mine effluent in Latte Creek
CC-3.5	Latte Creek immediately upstream of confluence with Coffee Creek	6970375	594319	Exposure	Oct-2010	
Coffee Creek						
CC-0.5	Coffee Creek immediately upstream of confluence with Latte Creek	6970225	594719	Reference	Oct-2010	Coffee Creek background
CC-4.5	Coffee Creek	6975084	598330	Exposure	Oct-2010	To assess effects of mine effluent on Coffee Creek below Latte Creek confluence
Halfway Creek						
HC-2.5	Halfway Creek midway	6976548	584089	Exposure	Oct-2010	To assess effects of mine effluent from mine on Halfway Creek
HC-5.0	Halfway Creek mouth	6980536	588823	Exposure	Oct-2010	
YT-24						
ML-1.0	Mouth of YT-24, small tributary to Yukon River draining part of mine site	6979073	589526	Exposure	June-2014	To assess effects of mine effluent in YT-24

Site	Drainage	Coordinates		Site	Sampling	Rationale
		North	East	Type	Start Date	
Independence Creek						
IC-0.5	Independence Creek – main stem	6976911	572012	Reference	Oct-2010	Reference Catchment (not influenced by Project)
IC-1.5	Un-named larger tributary to Independence Creek	6976835	572260	Reference	Oct-2010	
IC-2.5	Small un-named tributary to Independence Creek	6978044	572771	Reference	Oct-2010	
IC-3.0	Small un-named tributary to Independence Creek	6979357	575334	Reference	Oct-2010	
IC-4.5	Independence Creek - mouth	6983237	579358	Reference	Oct-2010	
Yukon River						
YUK-2.0	Yukon River upstream of Coffee Creek confluence	6975946	601011	Reference	Oct-2010	Background water quality
YUK-5.0	Yukon River downstream of Independence Creek confluence	6985228	579624	Exposure	Oct-2010	To assess effect of all mine-related discharge in Yukon River

In general, surface water samples were collected in accordance with the British Columbia Field Sampling Manual (Clark, 2003) as a similar set of standards has not yet been established for Yukon. This document prescribes a robust set of sampling procedures, sampling protocols and equipment that are applicable to sites in both British Columbia and Yukon.

During open water periods, sample filtering and preservation of samples for laboratory analysis was undertaken on-site. In winter, it was sometimes necessary to drill through ice with a lead or ice chisel to obtain a water sample. *In situ* water quality measurements (temperature, pH, specific conductance, dissolved oxygen (DO) and oxidation-reduction potential (ORP)) were also collected as part of each sampling event.

Samples collected at each station were analyzed for a suite of parameters (summarized in Appendix 12-A of the Project Proposal). Samples have been analyzed by Maxxam Analytics (Maxxam) of Burnaby B.C. for the duration of the program. Maxxam has Canadian Association for Laboratory Accreditation certification. Laboratory analytical methods were carried out using procedures described in APHA Standard Methods for the Examination of Water and Wastewater (2005), and methods employed were reported along with analytical results. For the baseline period of 2010 to 2016, laboratory detection limits have been low, and allowed for comparison of monitoring results with applicable water quality guidelines.

A Quality Assurance / Quality Control (QA/QC) program was conducted to avoid sampling error, prevent contamination by ensuring proper handling, and to quantify any bias in the results, so as to provide reliable monitoring data. Quality control samples, including method blanks, laboratory duplicates, and certified reference materials, were routinely included with water quality samples and all laboratory analyses. Field quality control samples included travel blanks, equipment blanks, field blanks, and field duplicates.

Maxxam provided all pre-cleaned bottles, preservatives and bottle labels used for the program. Results of laboratory duplicates, method blanks, and certified reference materials (CRMs) were included with each data report. These data provide an assessment of the precision, contamination control, and accuracy of analyses. The results of these quality control samples analyses were assessed using Maxxam's data quality objectives (DQOs) which have been developed for each analytical method. Maxxam has committed to providing results that have passed DQOs and QA/QC procedures.

3.3 Description of Existing Conditions

This section provides an overview of existing surface water quality conditions by catchment for Latte Creek, Coffee Creek, YT-24, Halfway Creek, Independence Creek, and Yukon River, based on the results of the baseline monitoring program described above. The purpose of this section is to provide a description of pre-Project conditions for surface water quality.

The temporal boundaries for baseline conditions extend from 2010 to January 2016. A robust baseline dataset has been compiled for surface water quality in the Project area, which includes one to five years of baseline data per monitoring station (18 stations) within this period, with sampling typically having occurred on a monthly basis. Data from 12 water quality stations are located in the LAA, including stations on Latte Creek, YT-24 and Halfway Creek, which will receive mine effluent, and two stations on the Yukon River. Six additional water quality stations, for the purposes of providing regional context in upper Coffee Creek, above the Latte Creek confluence, and in Independence Creek. Because there were no major developments or discharges to any of the catchments in the LAA or RAA throughout the duration of the baseline monitoring period (2010 to 2016), the terms "existing" and "baseline" are used interchangeably in this section.

Further information on the baseline monitoring program and on existing surface water quality conditions in the Project area can be found in the Coffee Gold Project Baseline Water Quality Report (**Appendix 12-A** of the Project Proposal), which includes tabulated water quality summary statistics for the baseline period, monthly data summaries, and raw monitoring data.

For the purposes of this VC assessment, data are summarized in this chapter for 10 stations sampled under the water quality monitoring program. These stations represent key monitoring locations at which potential project effects will be evaluated within the LAA. The data presented reflect trends in seasonal variability for each watercourse and reflect parameters naturally elevated within each catchment. Water quality data for each catchment and corresponding stations are presented in the following order:

- Latte Creek stations CC-1.5, mid-catchment, and CC-3.5, lower-catchment (**Section 3.3.1.1**)
- Coffee Creek stations CC-0.5, upstream of project influence, and CC-4.5, downstream of confluence with Latte Creek (**Section 3.3.1.1**)
- YT-24 station ML-1.0, lower-catchment near outlet (**Section 3.3.1.2**)
- Halfway Creek stations HC-2.5, mid-catchment, and HC-5.0, lower-catchment (**Section 3.3.1.3**)
- Independence Creek station IC-4.5 as the lower-catchment reference station (**Section 3.3.1.4**), and
- Yukon River stations YUK-2.0, upstream of the Coffee Creek confluence and Project influence, and YUK-5.0, downstream of the Independence Creek confluence and sites potentially influenced by the Project (**Section 3.3.1.5**).

This long-term and well-refined data set allowed for a robust characterization of the baseline condition, These data were incorporated into the site-wide water balance model, which was used to predict the potential changes to surface water quality (presented as monthly summaries) over the life of the Project.

Within the Project LAA and RAA, existing and predicted surface water quality naturally exhibits temporal variability (**Section 3.0**). An example of temporal variation on a monthly scale are the naturally occurring changes in water chemistry driven by relative proportions of groundwater and surface water comprising stream flow. Alternatively, long-term cyclical (*i.e.*, inter-annual) variability can result in wetter or drier than average precipitation years, resulting in annualized or multi-year changes to the relative proportion and chemistries of groundwater and surface water contributing to stream flow.

Summaries of monthly mean water quality data for these stations as well as all raw data for all stations for the period of October 2010 to January 2016 are presented in the Surface Water Quality Baseline Study Report Appendix 12-A.

3.3.1.1 Latte Creek and Coffee Creek

Baseline water chemistry data is presented in this section for Latte Creek stations CC-1.5 and CC-3.5, and for Coffee Creek stations CC-0.5 and CC-4.5 for the period of October 2010 to January 2016. Latte Creek is a tributary of Coffee Creek. Station CC-0.5 will remain a background station representative of the upper Coffee Creek catchment, which is the majority of the basin, draining an extensive area to the south of the mine site. Station CC-4.5 represents the effects of mine-related loading in Latte Creek, once it is fully mixed in Coffee Creek below the confluence (lower Coffee Creek), before it flows into the Yukon River.

Water chemistry in the Latte Creek and lower Coffee Creek drainages is driven by varying proportions of snow-melt driven surface runoff (lower ionic strength, higher organic content) and groundwater inputs (higher ionic strength, lower organic content) to surface flow, based on the seasonal water balance. This seasonality in water chemistry is more pronounced the higher a station occurs in the catchment.

Of the four stations presented here, station CC-1.5 is highest in the Coffee Creek / Latte Creek catchment. As such, this station is characterized by soft water, low in major ions during freshet periods, and hard to very hard waters, with high levels of major ions during winter low flow periods (**Figure 3.3-1**). Lower in the Latte Creek catchment at station CC-3.5, water chemistry shows a similar seasonality although annual minima and maxima are less pronounced compared to CC-1.5. Both CC-0.5 and CC-4.5 are characterized by soft to moderately-soft waters (between 35 mg/L and 75 mg/L; **Figure 3.3-1**) with lower levels of dissolved major ions (e.g., alkalinity, hardness, sulphate) during the open water period of May to September. During low flow periods, water chemistry at both stations is dominated by hard to very hard waters with high levels of dissolved solids, although annual maxima at CC-4.5 are less pronounced compared to CC-0.5. In contrast, pH remains relatively uniform throughout the Latte Creek and Coffee Creek drainages on an annual basis (7.0 to 8.0).

The influence of snow-melt driven surface runoff during the open water season and groundwater inputs during winter months is also reflected in time series for organic and trace element parameters. Peak summer flows typically coincide with annual maxima in TSS, dissolved organic carbon, dissolved aluminum, total Fe, and particulate-bound metals (e.g., T-As, T-Cd, T-Cu, T-Cr, and T-Zn). In contrast, the dominance of groundwater inputs during winter contributes to annual peaks in several dissolved metals, most notably uranium. Despite seasonally-associated concentration peaks noted above, mean monthly concentrations of total and dissolved trace elements (e.g., As, Sb, Co, Cr, Pb, Hg, Ni, Se, and Zn) are generally low.

Several parameters naturally exceed their corresponding CCME or BC WQGs throughout the Coffee Creek catchment in the baseline dataset (i.e., D-Al, T-Cd, T-Cr, T-Cu, T-Fe, T-U and T-Zn). In Latte Creek, D-Al, T-Fe and T-Cu regularly exceed their corresponding CCME long-term water quality guidelines during the open water season **(Figure 3.3-2**; **Figure 3.3-3**), with T-Cd and T-Cr commonly approaching or exceeding guidelines as well. The latter are attributed to elevated particulates in the water column during high flow events. During winter low flow periods, the total U concentration is consistently well above its CCME long term guideline on an annual basis (**Figure 3.3-4**). Total As and T-Se are typically below their WQGs year-round, although sporadic increases are observed in association with high-TSS events. Similar exceedances occur in the baseline monitoring dataset for Coffee Creek stations CC0.5 and CC4.5, with the exception of T-U at CC4.5, which has remained below the CCME guideline throughout the baseline period (**Figure 3.3-4**).

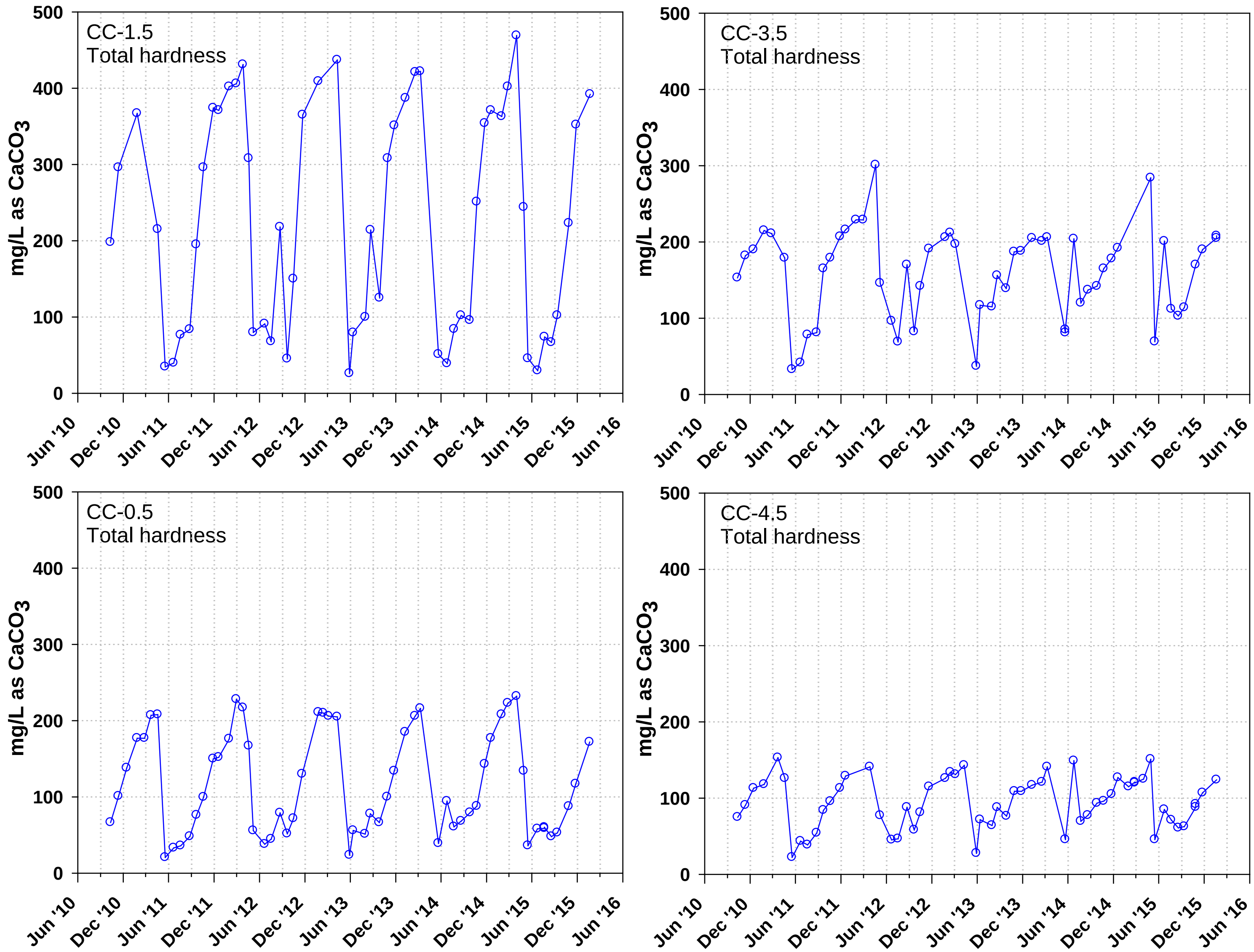

Figure 3.3-1 Time series for total hardness at stations CC-1.5, CC-3.5, CC-0.5, and CC-4.5 for October 2010 to January 2016

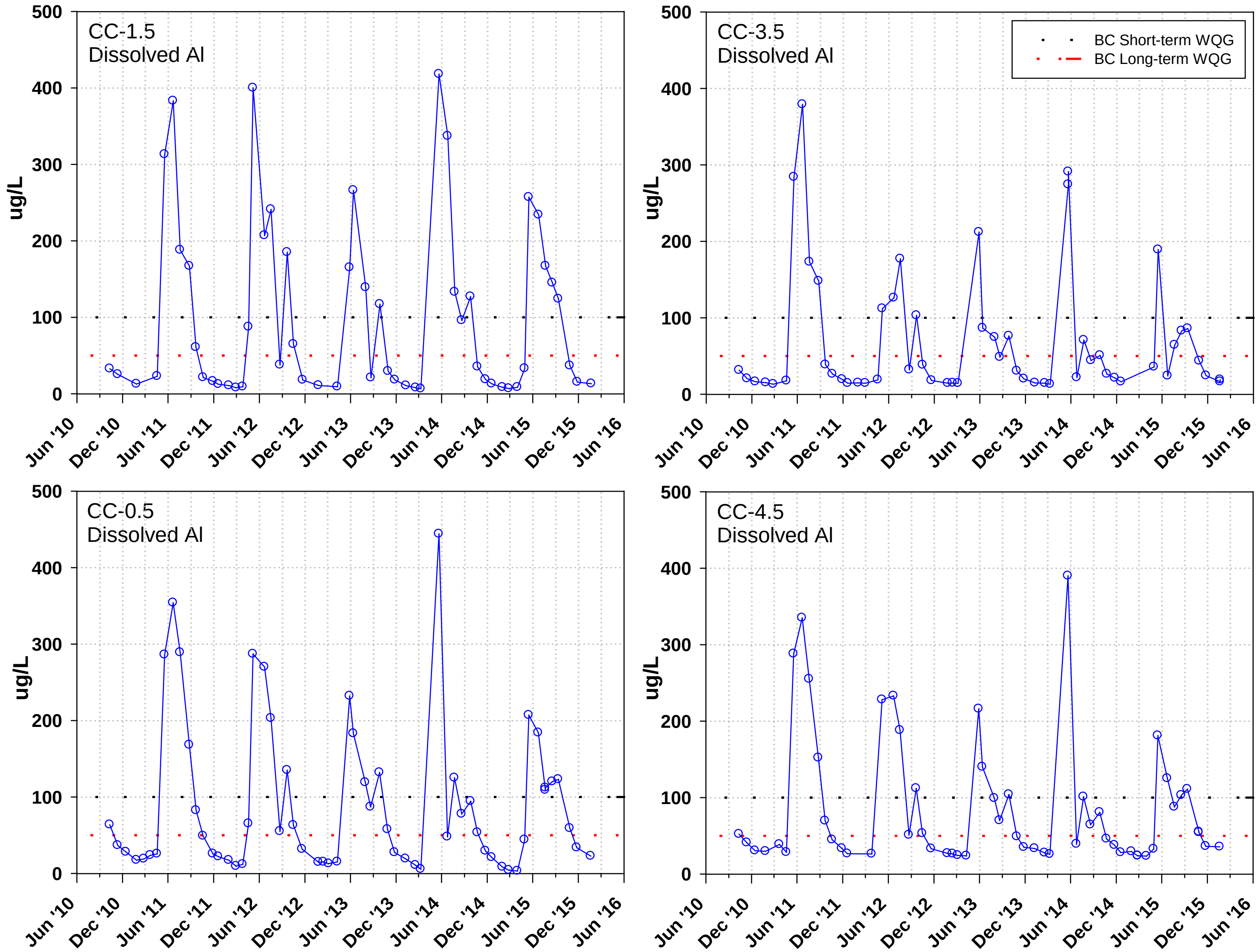

Figure 3.3-2 Time series for dissolved aluminum at stations CC-1.5, CC-3.5, CC-0.5, and CC-4.5 for October 2010 to January 2016. BC short-term (black dashed line) and long-term (30-day) (red dashed line) water quality guidelines assume pH<6.5

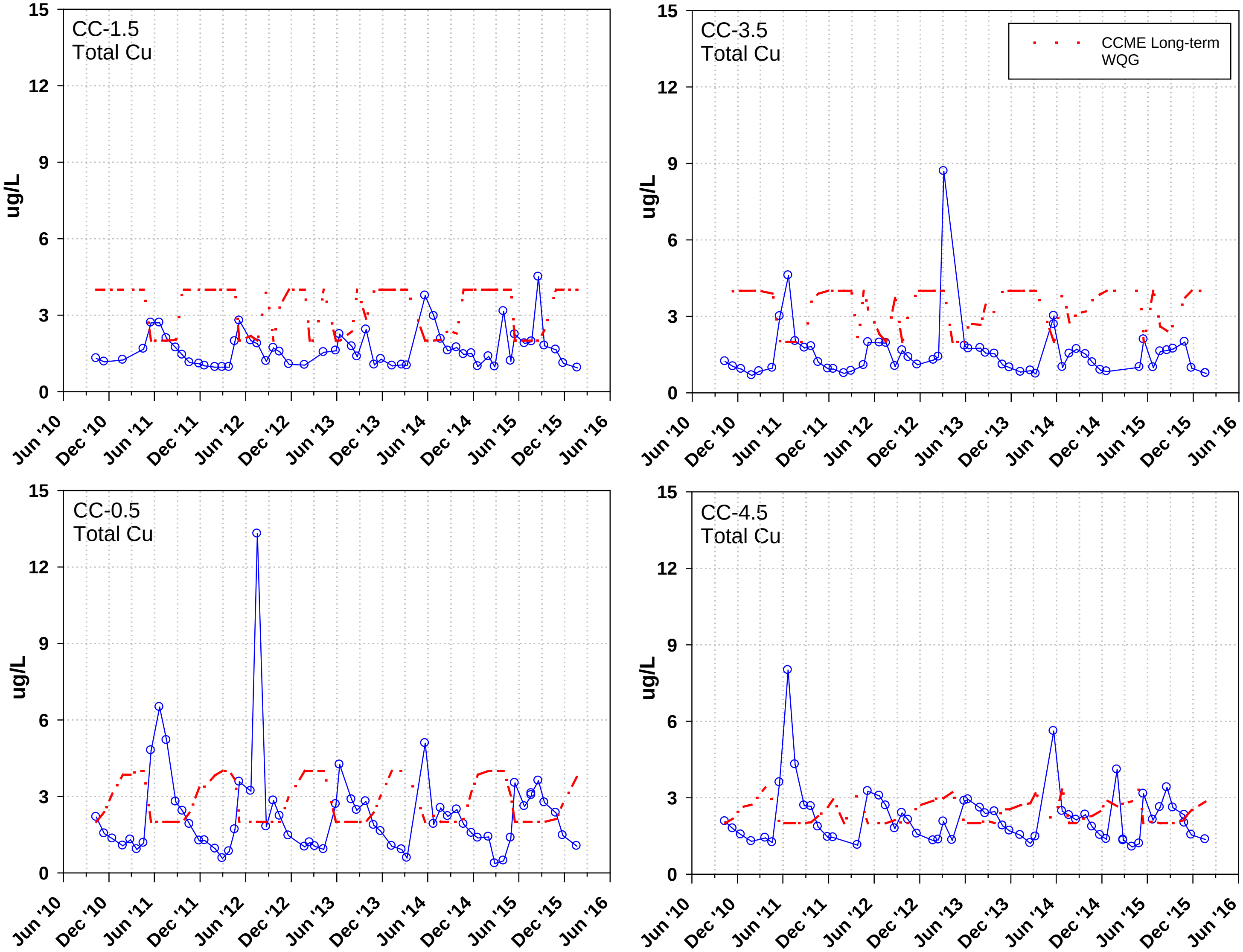

Figure 3.3-3 Time series for total copper at stations CC-1.5, CC-3.5, CC-0.5, and CC-4.5 for October 2010 to January 2016. CCME long-term water quality guideline (red dashed line) calculated from measured total hardness

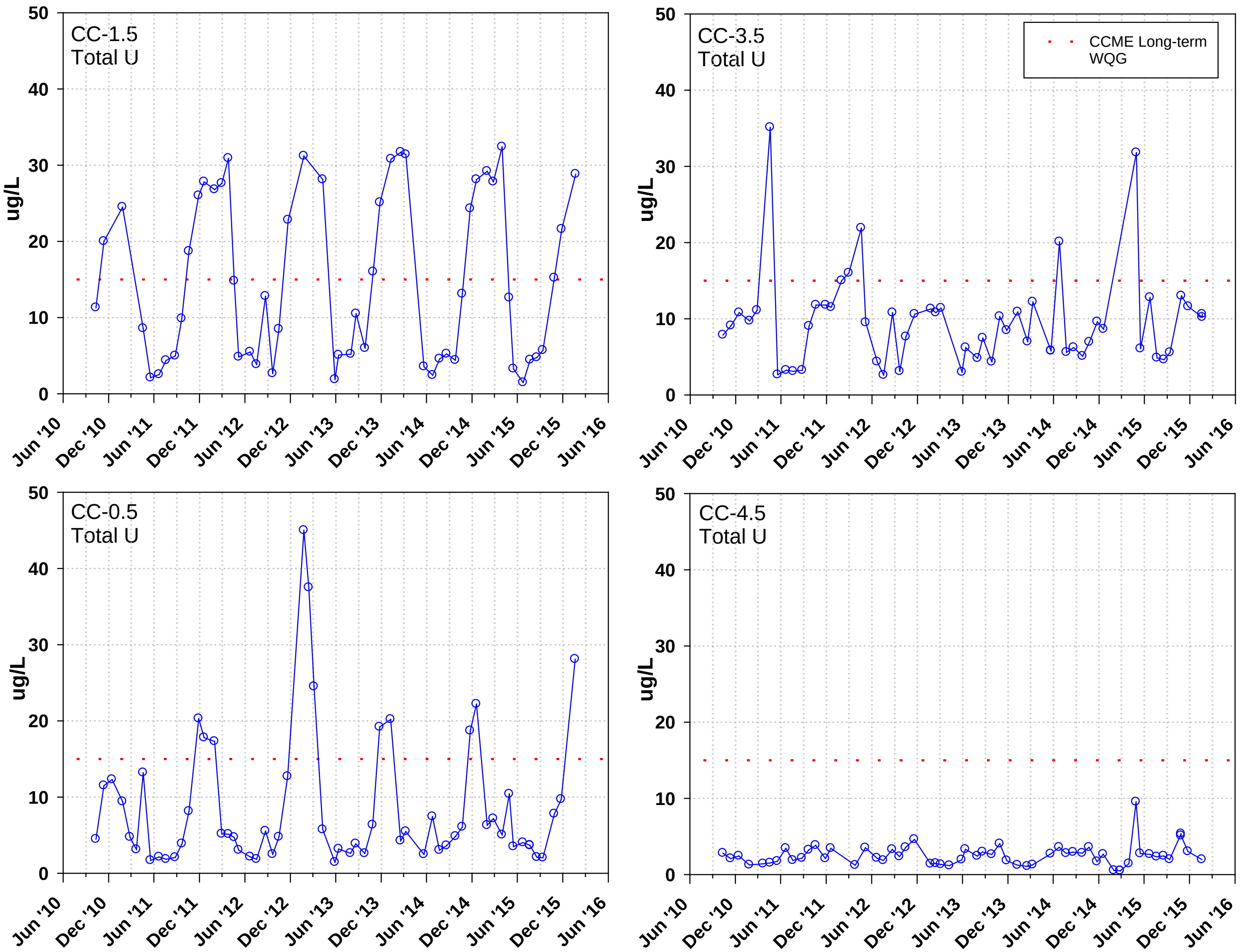

Figure 3.3-4 **Time series for total uranium at stations CC-1.5, CC-3.5, CC-0.5, and CC-4.5 for October 2010 to January 2016. CCME long-term water quality guideline shown as red dashed line**

3.3.1.2 YT-24 Tributary

Baseline water chemistry data is presented in this section for YT-24 tributary station ML-1.0 for the period of June 2014 to October 2016. Although baseline monitoring in the YT-24 catchment was initiated later compared to other catchments, the current dataset reflects over one year of baseline monitoring. Due to the ephemeral nature of flow in this catchment, monthly samples have been collected at ML-1.0 only during the open water period (April to October).

Unlike the Coffee Creek catchment, baseflow in YT-24 is not strongly associated with groundwater recharge. This is consistent with observations of low or no flow in YT-24 in winter months, and is supported by the baseline water quality dataset. More specifically, when environmental conditions support surface flow, YT-24 is characterized by moderately soft (**Figure 3.3-5**), low-ionic-strength waters, with circumneutral pH. Measured TSS concentrations are typically low, although peak flow events are associated with elevated TSS over 20 mg/L. Consistent with the dominant contribution of snow-melt driven surface runoff to stream flow, water chemistry at YT-24 commonly shows elevated levels of dissolved organic carbon, D-Al, T-Fe, and particulate-bound metals, although monthly mean concentrations of most trace elements (e.g., As, Sb, Co, Cr, Pb, Hg, Ni, Se, U and Zn) are low (see **Figure 3.3-5**).

Certain parameters naturally exceed their corresponding CCME or BC WQGs at ML-1.0 in the baseline dataset, chiefly D-Al, T-Cr, T-Cu, and T-Fe. Dissolved Al, T-Cu and T-Fe are naturally elevated on an annual basis, while T-Cd occasionally occurs near its CCME guideline as well (**Figure 3.3-5**). Increases to T-Cr are occasionally observed in association with elevated suspended solids.

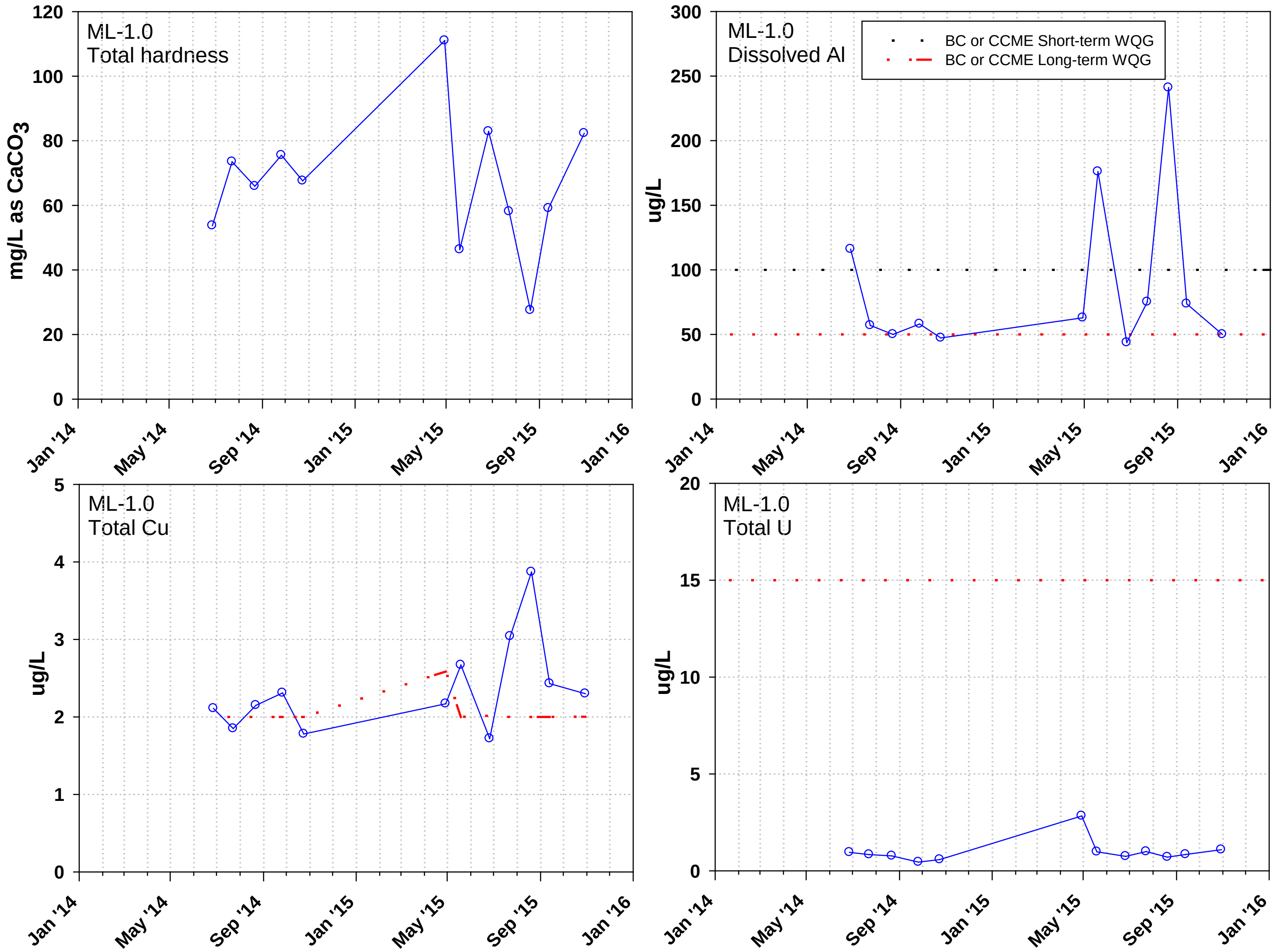

Figure 3.3-5 Time series for total hardness, dissolved aluminum, total copper, and total uranium at station ML-1.0 for June 2014 to October 2015. BC (D-Al) or CCME (T-Cu, T-U) long-term and short-term water quality guidelines are shown as red and black dashed lines, respectively

3.3.1.3 Halfway Creek

Baseline water chemistry data are presented in this section for Halfway Creek stations HC-2.5 and HC-5.0 for the period of October 2010 to January 2016. Although HC-5.0 is located lower in the Halfway Creek catchment compared to HC-2.5, samples were not obtained at HC-5.0 in the months of February or March due to absence of flow.

Similar to the Coffee Creek catchment, water chemistry in Halfway Creek is driven by varying proportions of melt-water surface runoff (lower ionic strength, higher organic content) and groundwater inputs (higher ionic strength, lower organic content) to surface flow. Several water quality parameters show a distinct seasonal signature.

Halfway Creek is characterized by soft water and low levels of major ions during freshet periods (**Figure 3.3-6**). During winter low flow periods, no flow is evident at HC-5.0, while HC-2.5 is characterized by hard to very hard waters with high levels of major ions. pH remains relatively uniform at the two stations in the Halfway Creek drainage on an annual basis, typically ranging between 7.0 and 8.0.

The influence of snow-melt driven surface runoff during the open water season and groundwater inputs during winter months is also reflected in time series concentrations of organic and trace element parameters. Similar to the Coffee Creek catchment, peak summer flows typically coincide with annual maxima in TSS, dissolved organic carbon, D-Al, T-Fe, and particulate-bound metals (e.g., T-As, T-Cd, T-Co, T-Cu, T-Cr, and T-Zn), as shown in **Figure 3.3-6** and **Figure 3.3-7**. In contrast, the dominance of groundwater inputs during winter contributes to annual peaks in certain dissolved metals, most notably T-U (see **Figure 3.3-7**). Despite seasonally-associated concentration peaks for many parameters, mean monthly concentrations of total and dissolved trace elements (e.g., As, Sb, Co, Cr, Pb, Hg, Ni, Se, and Zn) are typically low.

Several parameters have naturally exceeded their CCME or BC WQGs at least once in the baseline dataset (D-Al, T-As, T-Cr, T-Co, T-Cu, T-Fe, T-U, and T-Zn). Dissolved Al, T-Fe and T-Cu regularly exceed their corresponding CCME long-term water quality guidelines during the open water season (**Figure 3.3-6**; **Figure 3.3-7**). Total Cr, and other trace metals like T-Cd to a lesser extent, occasionally approach or exceed guidelines during summer high flows as well. During winter low flow periods, T-U consistently occurs well above its CCME long-term guideline on an annual basis (**Figure 3.3-7**). Total As and T-Se concentrations typically fall well below their WQGs year-round, although sporadic increases are observed in association with high-TSS events.

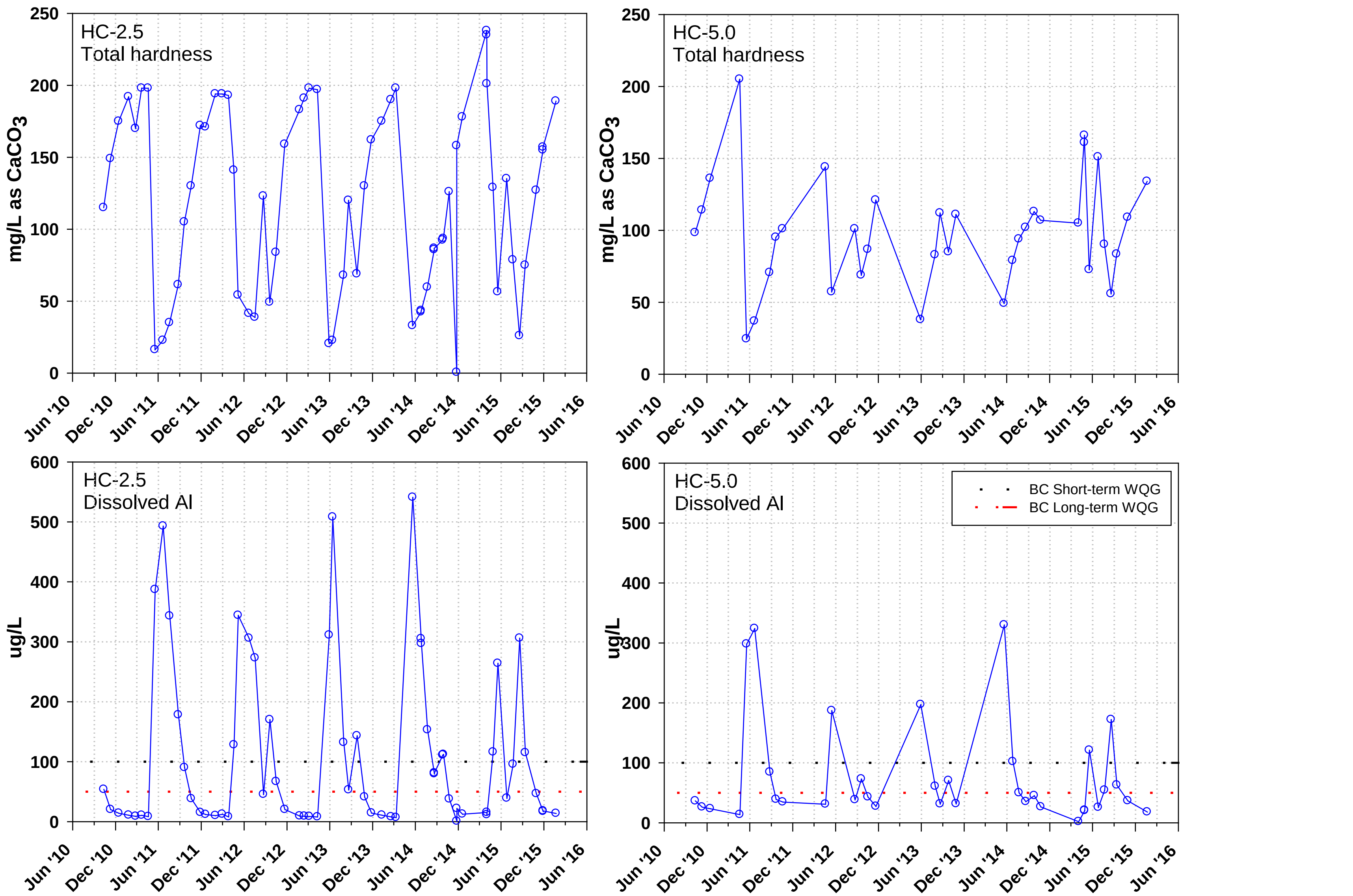

Figure 3.3-6 Time series for total hardness and dissolved aluminum at stations HC-2.5 and HC-5.0 for October 2010 to January 2016. CCME long-term and short-term water quality guidelines shown as red and black dashed lines, respectively

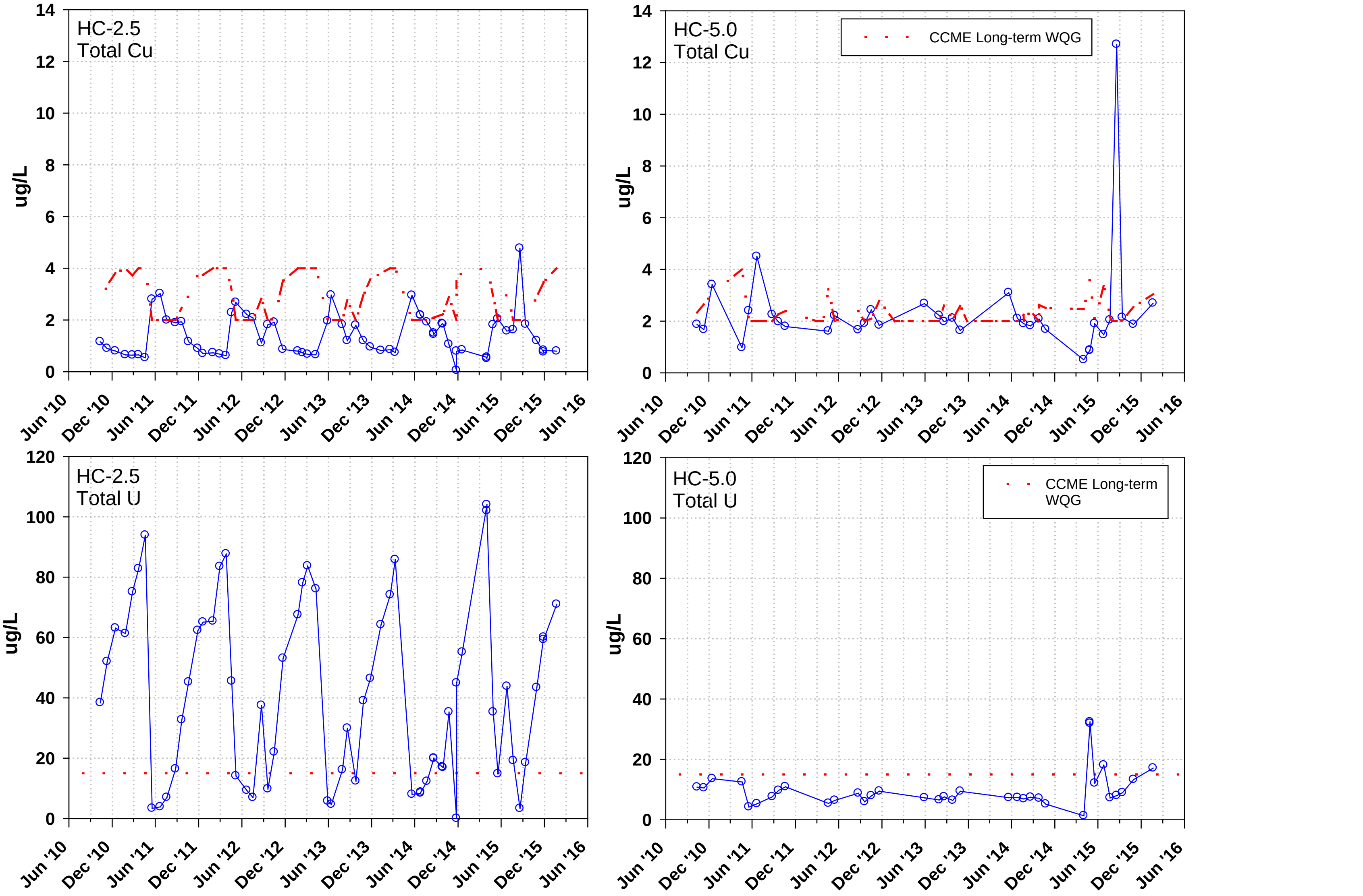

Figure 3.3-7 **Time series for total copper and total uranium at stations HC-2.5 and HC-5.0 for October 2010 to January 2016. CCME long-term water quality guideline shown as red dashed lines**

3.3.1.4 Independence Creek

Baseline water chemistry data are presented in this section for Independence Creek station IC-4.5 for the period of June 2014 to October 2016. The Independence Creek catchment lies outside of the area of Project disturbance; as such, baseline monitoring was conducted at this station as a reference for comparison to potential effects to catchments that will receive mine effluent.

Similar to the Coffee Creek catchment, water chemistry in Independence Creek is driven by varying proportions of melt-water surface runoff (lower ionic strength, but higher organic content and suspended particulates) and groundwater inputs (higher ionic strength, lower organic content) to surface flow, resulting in distinct seasonal trends. pH remains relatively uniform throughout the drainage on an annual basis, ranging between 7.0 and 8.0.

During freshet periods, Independence Creek is characterized by low levels of major ions, like sulphate, Ca, and Mg. Peak summer flows typically coincide with annual maxima in TSS, dissolved organic carbon, D-Al, T-Fe, and particulate-bound metals (e.g., T-As, T-Cd, T-Co, T-Cu, T-Cr, T-Mn and T-Zn) (**Figure 3.3-8**). Of these parameters, D-Al, T-Cd, T-Cr, T-Cu, T-Fe, and T-Zn have exceeded their BC or CCME WQG at least once in the baseline dataset. Dissolved Al, T-Fe and T-Cu regularly exceed their corresponding CCME long-term water quality guidelines during this period (**Figure 3.3-8**). Total Cr and T-Cd commonly approach or exceed guidelines during summer high flows as well. Despite seasonally-associated concentration peaks shown for many parameters, mean monthly concentrations of total and dissolved trace elements (e.g., As, Sb, Co, Cr, Pb, Hg, Ni, Se, and Zn) are typically low.

In contrast, the dominance of groundwater inputs during winter months contributes to annual peaks in hardness, alkalinity, and major ions, like Ca and Mg. Total U is low throughout Independence Creek (**Figure 3.3-8**) and does not show the seasonal winter peaks observed in the drainages in the LAA.

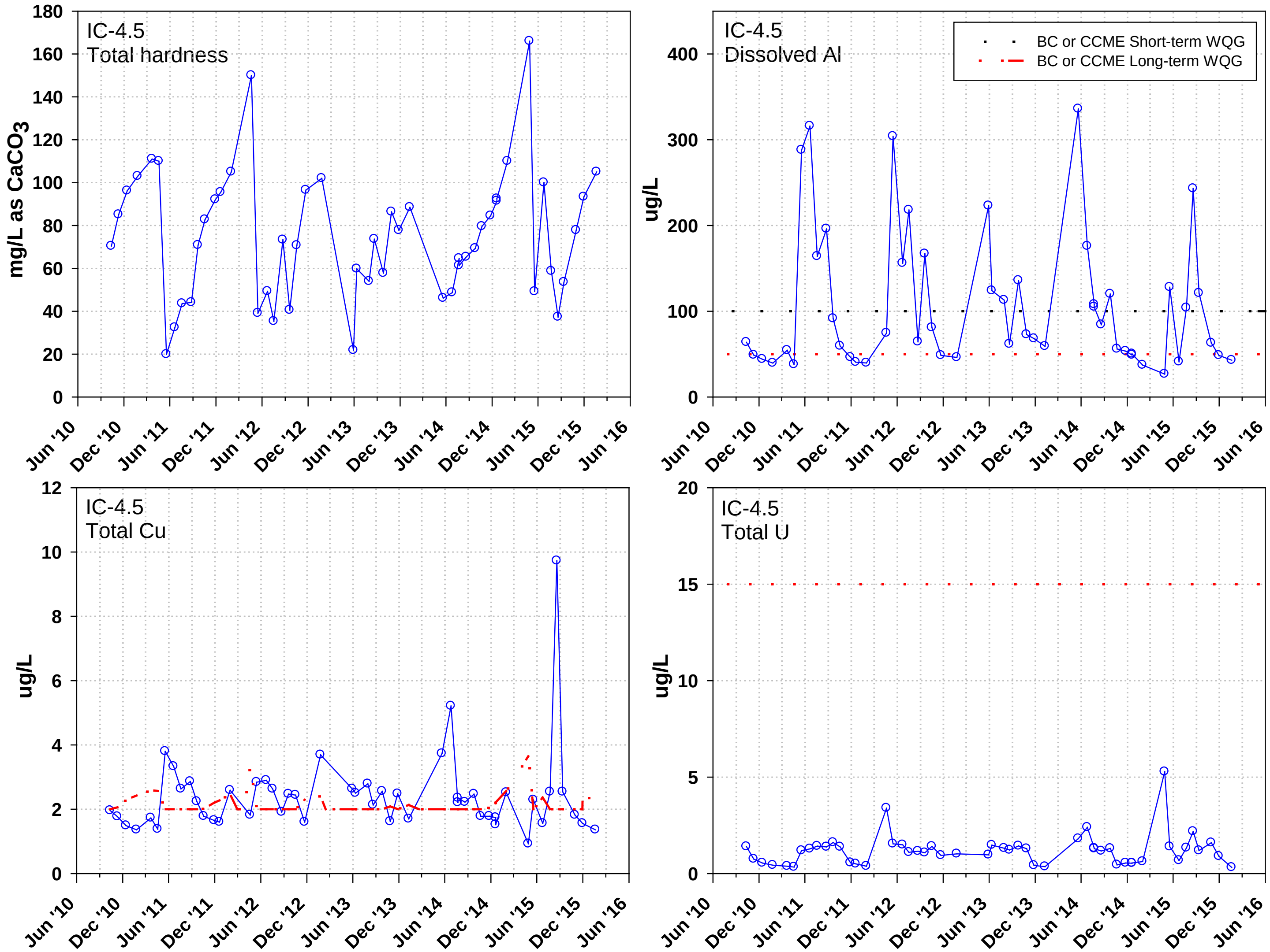

Figure 3.3-8 Time series for total hardness, dissolved aluminum, total copper, and total uranium at station IC-4.5 for October 2010 to January 2016. CCME long-term and short-term water quality guidelines shown as red and black dashed lines, respectively

3.3.1.5 Yukon River

Baseline water chemistry data are presented in this section for Yukon River stations YUK-2.0 and YUK-5.0 for the period of October 2010 to January 2016. YUK-2.0 occurs immediately upstream of all mine-related discharges. YUK-5.0 occurs downstream of all potential Project-related surface and groundwater discharges that may report to the Yukon River via the Coffee Creek catchment (including Latte Creek), the YT-24 catchment, and Halfway Creek.

Yukon River stations YUK-2.0 and YUK-5.0 are characterized by consistently hard waters with low to moderate levels of major ions (**Figure 3.3-9**). pH levels are generally circum-neutral to slightly basic, which is attributed to bicarbonate alkalinity. The strong seasonal water quality signature observed in smaller creeks in the Project area associated with winter groundwater inputs is largely absent from the Yukon River, presumably due to its large catchment.

During summer high flow, however, the Yukon River shows concentration peaks for certain organic parameters (e.g., Dissolved Organic Carbon (DOC)), nutrients (T-P), TSS, and metals, including D-Al, T-As, T-Cd, T-Cr, T-Cu, T-Fe, T-Mn, T-Ni, T-Pb, and T-Zn. Of these parameters, D-Al, T-As, T-Cd, T-Cr, T-Cu, T-Fe, T-Zn have exceeded BC or CCME WQGs during the baseline monitoring period.

Mean monthly total arsenic concentrations at both YUK-2.0 and YUK-5.0 are typically well below 1.0 µg/L for most flow periods of the year, with the exception of maximum values coincident with elevated TSS during spring freshet. Total U concentrations are also low year-round. Mean monthly D-Al concentrations at stations YUK-2.0 and YUK-5.0 were also lower relative to stations in other tributaries in the LAA, but commonly exceed the BC long-term (30-day) WQG during summer flows.

Concentrations of total Cu at YUK-2.0 and YUK-5.0 routinely exceed the CCME hardness-based Cu guideline, despite consistently elevated hardness (**Figure 3.3-9**). Mean monthly T-Cu concentrations at both Yukon River stations indicate that elevated T-Cu concentrations are associated with the peak flow months of May and June (**Figure 3.3-10**). Similar to Cu, T-Cd concentrations slightly exceed the CCME long-term guideline typically during peak flow periods. Despite annual concentration peaks for certain parameters during summer high flows, mean monthly concentrations of most total and dissolved trace elements are low, including T-U which consistently falls below its CCME long-term WQG in the Yukon River (**Figure 3.3-10**).

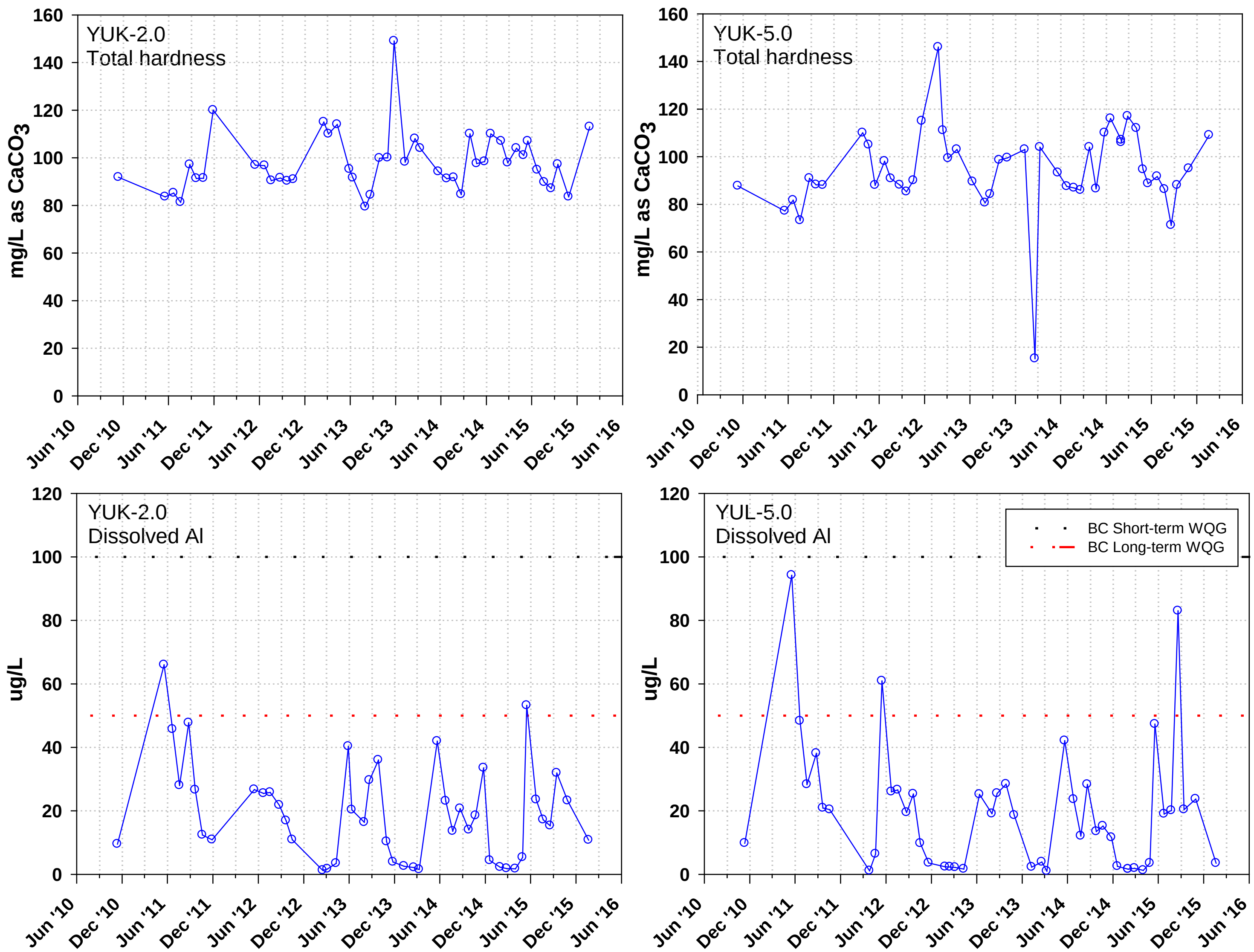

Figure 3.3-9 Time series for total hardness and dissolved aluminum at stations YUK-2.0 and YUK-5.0 for October 2010 to January 2016. BC long-term and short-term water quality guidelines shown as red and black dashed lines, respectively

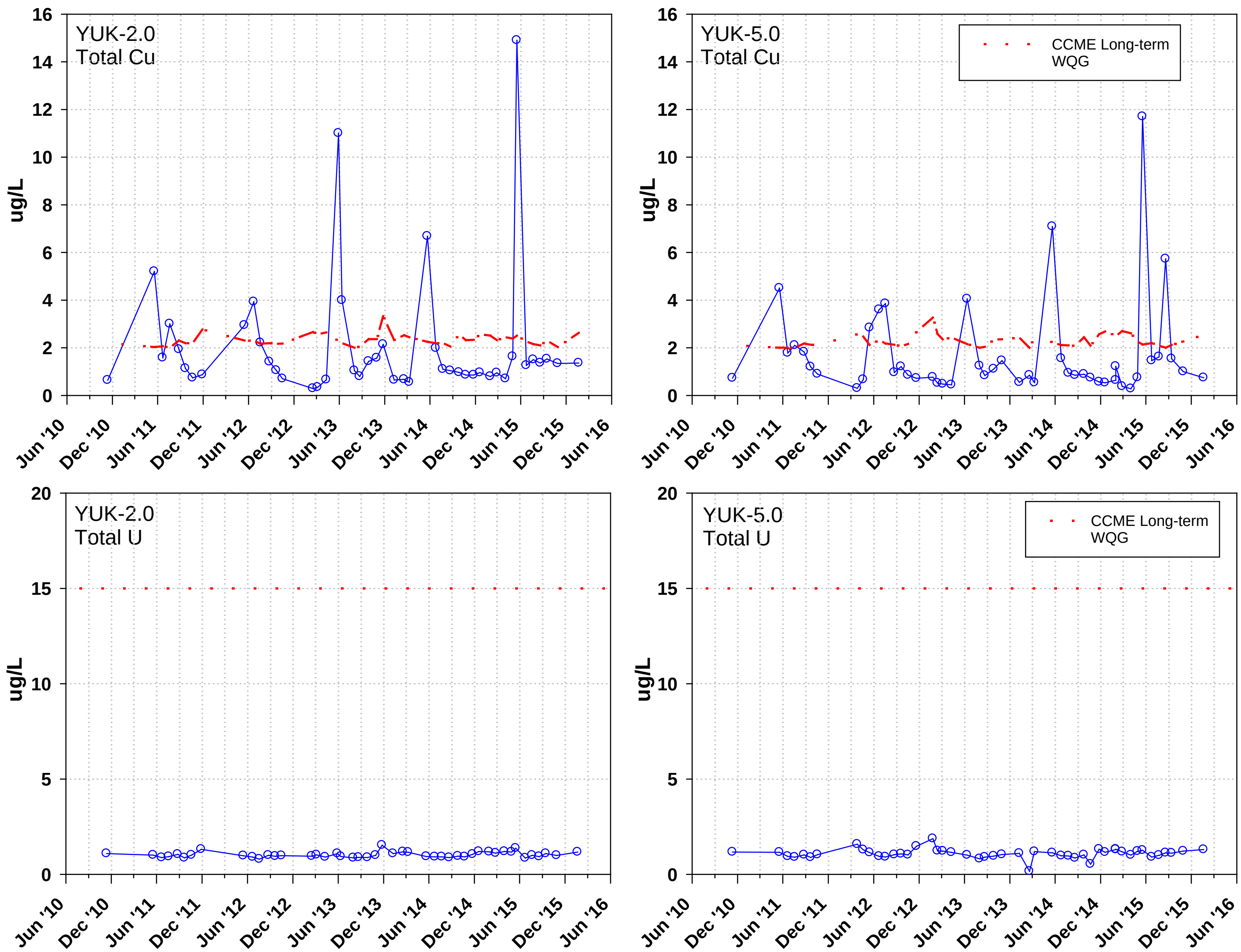

Figure 3.3-10 Time series for total copper and total uranium at stations YUK-2.0 and YUK-5.0 for October 2010 to January 2016. CCME

4.0 ASSESSMENT OF PROJECT-RELATED EFFECTS

This section presents the assessment of potential Project-related effects to surface water quality. **Section 4.1** identifies and describes potential interactions between Project activities and surface water quality during the Construction, Operation, Reclamation and Closure, and Post-closure phases, as well as potential effects resulting from those interactions. **Section 4.2** summarizes potential effects to surface water quality resulting from Project interactions, and **Section 4.3** outlines technically and economically feasible mitigation measures proposed to eliminate, reduce, or otherwise control potential effects to surface water quality. Lastly, **Section 4.4** presents water balance model results for residual effects (i.e., those potential effects that cannot be fully avoided or reduced through mitigation measures), and provides an effects characterization for each anticipated residual effect (i.e., those that are not considered to be negligible effects) by surface water quality catchment, along with a determination of significance.

4.1 POTENTIAL PROJECT-RELATED INTERACTIONS WITH SURFACE WATER QUALITY

The purpose of this section is to focus the assessment on those interactions of greatest potential consequence to surface water quality. To achieve this objective, the potential for interactions between Project components and activities and surface water quality are considered. Each potential interaction is rated using the terms that are defined in **Table 4.1-1**.

Table 4.1-1 Potential for an Interaction between Surface Water Quality and the Project

Term	Definition
No Interaction	Project component or activity will not interact with the surface water quality VC.
Negligible Interaction	Interaction with the Project component or activity is not expected to influence the short- or long-term integrity of the surface water quality VC (i.e., the effects resulting from the interaction are not anticipated to be measurable of detectable for the relevant indicator). The rationale is provided to support the rating of a negligible interaction and effect.
Potential Interaction	Interaction with the Project component or activity may have a measurable or detectable influence on the short- or long-term integrity of the surface water quality VC. The rationale is provided to support the rating of a potential interaction and effect, and the interaction is considered further in the effects assessment.

A brief description of the interaction, the interaction rating, nature of the interaction and potential effect (including the rationale for the rating) is documented in **Table 4.1-2**. For activities with the potential to interact with surface water quality (identified as 'potential interaction' in **Table 4.1-2**), it is expected that effects may be realized through various pathways and different interactions through life of mine. Potential effects associated with identified Project-surface water quality interactions for each Project phase were identified based on previous project experience, professional judgement, discussions with regulators and stakeholders, and potential effects identified through ICs linked to surface water quality (including groundwater (see Section 7.0 and Appendix 7-B), hydrology (see Section 8.0 and Appendix 8-B), and air quality (see Section 9.0 and Appendix 9-B)), and potential effects to the surficial geology, terrain, and soils VC (see Section 11.0 and Appendix 11-B).

Potential and residual effects, respectively, have been assessed through anticipated qualitative changes in indicators including TSS, turbidity, other physical parameters (pH, conductivity, hardness, total dissolved solids), cyanide species (total cyanide, weak acid dissociable cyanide), nutrients (total phosphorus and nitrogen species), biological oxygen demand (BOD) and chemical oxygen demand (COD), and total and dissolved metals (described in **Table 4.1-2** and **Section 4.2**), as well as through quantitatively-determined changes in these indicators - see **Section 3.4**). The mechanisms that may lead to potential changes in these indicators and result in potential changes to surface water quality include the following:

- Erosion and sedimentation
- Leaching (release) from disturbed mine materials/waste (or disturbed material along the NAR)
- Leaching of nitrogen residues generated from blasting
- Discharge of treated camp waste water
- Leaching of HLF residues
- Groundwater and surface water interactions and seepage, and
- Atmospheric deposition (i.e., dust fall).

For each Project interaction listed in **Table 4.1-2**, the description of the nature of the interaction includes the mechanisms that may contribute to potential effect to surface water quality. Additional details on potential effects pertaining to each mechanism are provided in **Section 4.2**.

Table 4.1-2 Potential Project Interactions with Surface Water Quality

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
Construction Phase (Year -3 through Year -1)				
Overall Mine Site	C-0	Confirmatory geotechnical drilling in select areas at the mine site, as necessary	Negligible Interaction	Changes to surface water quality from this activity may occur from erosion and sedimentation or groundwater and surface water interactions, and effects to surface water quality, if any, are anticipated to be localized (limited to a small footprint around the drilling area). Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-1	Mobilization of mobile equipment and construction materials	Potential Interaction	Areas in which this activity will occur overlap spatially with the headwaters of Latte, YT-24 and Halfway creeks. Potential effects may result from erosion and sedimentation (on and adjacent to road surfaces), or atmospheric deposition (dust fall). Such interactions may affect surface water quality by elevating levels of TSS and turbidity, and total and dissolved metals.
	C-2	Clearing, grubbing, and grading of areas to be developed within the mine site	Potential interaction	Areas in which this activity will occur overlap spatially with the headwaters of Latte, YT-24 and Halfway creeks. Potential effects may include erosion and sedimentation, or atmospheric deposition that may result in elevated TSS and turbidity concentrations, and associated total and dissolved metals in surface water. This effect is expected to continue through Operations Phase.
	C-3	Material handling	Potential interaction	This activity within the Mine Site will overlap spatially with the headwaters of Latte, YT-24 and Halfway creeks where surface water runoff has the potential to flow into watercourses. Potential effects may result from erosion and sedimentation or atmospheric deposition during the transport of waste rock, ore, or other materials on roads or during other associated handling activities. This activity may elevate TSS and turbidity concentrations and associated total and dissolved metals in surface waters.
Open Pits	C-4	Development of Latte pit and Double Double pit	Potential interaction	As pits are developed, ore will be transported to the ROM stockpile, and waste rock to the Alpha WRSF. Potential effects to surface water quality may result from erosion and sedimentation, atmospheric deposition, or leaching (release) of nitrogen blasting residues. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, physical parameters, nutrients, and total and dissolved metals. Leaching of disturbed mine materials/waste is not expected to occur in Construction Phase.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	C-5	Dewatering of pits (as required)	Potential interaction	This activity will occur within the headwaters of Latte and Halfway creeks. Potential effects may result from erosion and sedimentation to areas downstream of the point of discharge, leaching of nitrogen residues generated from blasting, leaching from disturbed mine materials/waste, or groundwater and surface water interactions and seepage. Such interactions may result in potential effects to surface water quality by elevating levels of TSS and turbidity, physical parameters, nutrients, and total and dissolved metals.
Waste Rock Storage Facilities	C-6	Development and use of Alpha WRSF	Potential interaction	This activity will occur within the headwaters of Halfway Creek. Potential effects to surface water quality may result from erosion and sedimentation, atmospheric deposition, leaching of nitrogen residues generated from blasting, leaching of disturbed mine materials/waste, or groundwater and surface water interactions and seepage, Such interactions may affect surface water quality by elevating levels of TSS and turbidity, physical parameters, nutrients, and total and dissolved metals.
Stockpiles	C-7	Development and use of temporary organics stockpile for vegetation and topsoil	Potential interaction	This activity will occur within the headwaters of Halfway Creek. Potential effects may result from erosion and sedimentation, or atmospheric deposition, which may affect surface water quality by elevating TSS and turbidity concentrations and associated total and dissolved metals.
	C-8	Development and use of frozen soils storage area	Potential interaction	This activity will occur within the headwaters of Halfway Creek. Potential effects may result from erosion and sedimentation, atmospheric deposition, or disturbed mine materials/waste leachate, which may affect surface water quality by elevating TSS and turbidity concentrations and associated total and dissolved metals.
	C-9	Development and use of run-of-mine (ROM) stockpile for temporary storage of ROM ore	Potential interaction	This activity will occur within the headwaters of Latte Creek. The ROM stockpile will be on a lined pad, with drainage collected from the pad and routed to the process plant. Potential effects may result from erosion and sedimentation, atmospheric deposition, leaching of nitrogen residues from stockpiled ore, or disturbed mine materials/waste leachate, which may affect surface water quality by elevating TSS and turbidity concentrations and associated total and dissolved metals.
Crusher System	C-10	Construction and operation of crushing circuit	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the crushing circuit) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	C-11	Construction and operation of crushed ore stockpile	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the ore stockpile) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Heap Leach Facility	C-12	Staged heap leach facility (HLF) construction, including associated event ponds, rainwater pond, piping, and water management infrastructure	Potential interaction	This activity will occur within the headwaters of Latte and Halfway creeks. The HLF will be constructed on a lined pad, and the ponds will also be lined. All contact water will be collected and recycled within the HLF through to the end of operations phase, and three separate leak detection systems will be employed (horizontal wick drains under each collection ditch or berm, electrical leak location surveys, and monitoring wells adjacent to the pad) to allow for early detection and remedy of any potential leak. Potential effects to surface water quality associated with leaching of nitrogen residues generated from blasting or from leaching from ore, therefore, are not expected. Potential effects from construction of the HLF pad and ponds and liner installations are expected to be localized and may result from erosion and sedimentation, atmospheric deposition. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, nutrients, and total and dissolved metals.
	C-13	Heap leach pad loading	Negligible interaction	Changes to surface water quality from this activity resulting from erosion and sedimentation or atmospheric deposition are anticipated to be localized and within existing ranges of surface water quality indicators. All contact water will be collected and recycled within the HLF through to the end of operations phase, and three separate leak detection systems will be employed (horizontal wick drains under each collection ditch or berm, electrical leak location surveys, and monitoring wells adjacent to the pad) to allow for early detection and remedy of any potential leak. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Plant Site	C-14	Construction and operation of process plant	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the process plant) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-15	Construction and operation of reagent storage area and on-site use of processing reagents	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the reagent storage area) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	C-16	Construction and operation of laboratory, truck shop, and warehouse building	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the laboratory, truck shop and warehouse building) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-17	Construction and operation of power plant	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the power plant) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-18	Construction and operation of bulk fuel/LNG storage and on-site use of diesel fuel or LNG	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprint of the fuel storage area) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Camp Site	C-19	Construction and operation of dormitories, kitchen, dining, and recreation complex buildings; mine dry and office complex; emergency response and training building; fresh (potable) water and fire water use systems; and sewage treatment plant	Potential interaction	This activity will occur within the headwaters of Latte and Halfway creeks. Changes to surface water quality from camp site construction, if any, resulting from erosion and sedimentation, atmospheric deposition, or leaching of nitrogen residues generated from blasting (if required for construction) are anticipated to be localized (limited to the small footprint of the camp area) and within existing ranges of surface water quality indicators. Changes to surface water quality from the discharge of camp wastewater may elevate levels of nutrients (total P, ammonia, nitrite, and nitrate), biological oxygen demand, and chemical oxygen demand. Such increases may affect surface water quality by contributing to eutrophication and hypoxia/anoxia in the receiving environment.
	C-20	Construction and operation of waste management building and waste management area	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation or atmospheric deposition (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized (limited to the small footprints of the waste management building and area) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
Bulk Explosive Storage Area	C-21	Construction of storage facilities for explosives components and on-site use of explosives	Potential interaction	The storage of explosives will occur within the headwaters of YT-24 Creek, and potential adverse effects to surface water quality (during construction of the facility) may result from erosion and sedimentation, atmospheric deposition, or the leaching of nitrogen residues generated from blasting (if required). Potential effects are anticipated to be localized (limited to the small footprint of the storage area) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, construction of these facilities are not considered further in this assessment. The onsite use of explosives has the potential to interact with surface water quality from the leaching of nitrogen residues generated from blasting activities in Mine Site development, and groundwater and surface water interactions and seepage. These interactions may affect surface water quality by elevating levels of ammonia and nitrogen.
Mine Site and Haul Roads	C-22	Upgrade, construction, and maintenance of mine site service roads and haul roads	Potential interaction	This activity will occur within the headwaters of Latte, YT-24 and Halfway creeks. Potential effects may include erosion and sedimentation (on and adjacent to road surfaces), and atmospheric deposition that may result in elevated TSS and turbidity concentrations and associated total and dissolved metals.
Site Water Management Infrastructure	C-23	Development and use of sedimentation ponds and conveyance structures, including discharge of compliant water	Potential interaction	This activity will occur within the headwaters of Latte, YT-24 and Halfway Creeks. Potential effects may result from erosion and sedimentation, atmospheric deposition, leaching of nitrogen residues generated from blasting (if required for construction), or groundwater and surface water interactions and seepage. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, nutrients, and total and dissolved metals.
	C-24	Initial supply of HLF process water	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.
	C-25	Ongoing use of site contact water (i.e., precipitation, stored rainwater) as HLF process water	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.
Ancillary Components	C-26	Upgrade of existing road sections for Northern Access Route (NAR), including installation of culverts and bridges	Potential interaction	This activity will overlap spatially with watercourses that cross the existing portion of the NAR. Potential effects may include erosion and sedimentation, atmospheric deposition, leaching from disturbed material, and leaching of nitrogen residues generated from blasting (if required), that may result in elevated TSS and turbidity, physical parameters, nutrients, and/or total and dissolved metals.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	C-27	Construction of new road sections for NAR, including installation of culverts and bridges	Potential interaction	See Activity C-26.
	C-28	Development, operation, and maintenance of temporary work camps along road route	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation, atmospheric deposition, or discharge of treated camp wastewater (or leaching of nitrogen residues generated from blasting, if required for construction) are anticipated to be localized footprints and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-29	Vehicle traffic, including mobilization and re-supply of freight and consumables	Potential interaction	This activity may overlap with areas where surface water runoff flows into watercourses along the NAR and at the Mine Site. Potential effects from this activity may result from sedimentation and erosion, and atmospheric deposition.
	C-30	Development, operation, and maintenance of barge landing sites on Yukon River and Stewart River	Negligible interaction	This activity will occur at localized areas on the Yukon and Stewart rivers. Changes to surface water quality, if any, from this activity are not expected to be detectable in the Stewart or Yukon rivers. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-31	Barge traffic on Stewart River and Yukon River, including barge mobilization of equipment for NAR construction	Negligible interaction	This activity will occur at localized areas on the Yukon and Stewart rivers. Changes to surface water quality, if any, from this activity are not expected to be detectable in the Stewart or Yukon rivers. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-32	Annual construction, operation, maintenance, and removal of Stewart River and Yukon River ice roads	Negligible interaction	This activity will occur at localized areas on the Yukon and Stewart rivers. Changes to surface water quality, if any, from this activity are not expected to be detectable in the Stewart or Yukon rivers. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-33	Annual construction and operation of winter road on the south side of the Yukon River	Negligible interaction	This activity will occur at a localized area on the Yukon River. Changes to surface water quality, if any, from this activity are not expected to be detectable in the Yukon River. Since any effects are expected to be negligible, this activity is not considered further in this assessment.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	C-34	Construction, operation, and maintenance of permanent bridge over Coffee Creek	Potential interaction	This activity will overlap with a riparian area on Coffee Creek. Potential adverse effects during construction may include erosion and sedimentation, atmospheric deposition, leaching from disturbed areas, and leaching of nitrogen residues generated from blasting (if required for construction of bridge abutments). This activity may result in elevated levels of TSS and turbidity, physical parameters, nutrients, and/or total and dissolved metals.
	C-35	Construction and maintenance of gravel airstrips	Potential interaction	This activity will occur in the Latte and Coffee Creek drainages. Potential effects may include erosion (of the airstrip and adjacent disturbed surfaces) and sedimentation, and atmospheric deposition. This activity may result in elevated TSS and turbidity concentrations and associated total and dissolved metals.
	C-36	Air traffic	No interaction	Take-off and landing will occur at the height of land separating Latte and YT-24 watersheds. While some minimal dust fall is likely, no interaction with surface water quality is anticipated from this activity and it is not considered further in this assessment.
	C-37	Use of all laydown areas	Negligible interaction	This activity will occur within watersheds at the Mine Site and along the NAR. Potential effects may result from erosion (of the laydown areas and adjacent disturbed surfaces) and sedimentation, or atmospheric deposition from their use, resulting in elevated TSS and turbidity concentrations and associated total and dissolved metals. Potential effects to surface water quality, if any, are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	C-38	Use of Coffee Exploration Camp	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.
Operation Phase (Year 1 through 12)				
Overall Mine Site	O-1	Material handling	Potential interaction	See Activity C-3.
	O-2	Excavation of contaminated soils followed by on-site treatment or temporary storage and off-site disposal	Potential interaction	This activity may overlap spatially with the headwaters of Latte, YT-24 and Halfway creeks, depending on the location of excavation and storage. Potential effects, although localized, may result from erosion and sedimentation or atmospheric deposition (during excavation), thereby elevating levels of TSS and turbidity contaminants (e.g., hydrocarbons), and total and dissolved metals. No interaction is anticipated for on-site treatment of contained material or off-site disposal.
	O-3	Progressive reclamation of disturbed areas within mine site footprint	Potential interaction	This activity will occur within the headwaters of Latte, YT-24 and Halfway creeks. Potential effects may result from erosion and sedimentation, and atmospheric deposition that may result in elevated TSS and turbidity concentrations and associated total and dissolved metals.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
Open Pits	O-4	Development of Kona pit and Supremo pit and continued development of Double Double pit and Latte pit	Potential interaction	As pits are developed, ore will be transported to the ROM stockpile, and waste rock transported to the Alpha WRSF. Potential effects may result from erosion and sedimentation, atmospheric deposition, leaching of disturbed mine materials/waste, leaching of nitrogen blasting residues, or groundwater and surface water interactions and seepage. These interactions are expected to result in potential effects to surface water quality, as determined by changes in TSS and turbidity, physical parameters, nutrients, and total and dissolved metals levels.
	O-5	Cessation of mining at Double Double pit, Latte pit, Kona pit, and Supremo pit	Potential interaction	This activity will occur within the headwaters of Latte, YT-24 and Halfway creeks. Potential effects may result from the leaching from disturbed mine materials/waste, nitrogen residue leaching, and groundwater and surface water interactions and seepage, may elevate concentrations in surface water quality of physical parameters, and total and dissolved metals. These potential effects will depend, in part, on surface water discharges from the Latte and Supremo pits, once closed. Surface water is not expected to discharge from the Double Double or Kona pits.
	O-6	Partial backfill of Latte pit and Supremo pit	Potential interaction	This activity will occur within the headwaters of Latte Creek, YT-24 and Halfway creeks. Potential effects may result from leaching from disturbed mine materials/waste, nitrogen residue leaching, and groundwater and surface water interactions and seepage, thereby elevating levels of physical parameters, and total and dissolved metals. Potential effects to surface water quality will depend, in part, on surface water discharges from the Latte and Supremo pits, once partially backfilled.
	O-7	Backfill of Double Double pit and Kona pit	Potential interaction	This activity will occur within the headwaters of Latte and Halfway creeks. Potential effects may result from leaching from disturbed mine materials/waste, nitrogen residue leaching, and groundwater and surface water interactions and seepage. Such interactions may result in potential effects to surface water quality by elevating levels of physical parameters, and total and dissolved metals.
	O-8	Dewatering of pits (as required)	Potential interaction	This activity will occur within the headwaters of Latte, YT-24, and Halfway creeks. Potential effects may result from erosion and sedimentation to areas downstream of the point of discharge, leaching of nitrogen residues generated from blasting, leaching from disturbed mine materials/waste, or groundwater and surface water interactions and seepage. Such interactions may result in potential effects to surface water quality by elevating levels of TSS and turbidity, physical parameters, nutrients, and total and dissolved metals.
Waste Rock Storage Facilities	O-9	Continued development and use of Alpha WRSF	Potential interaction	See Activity C-6.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	O-10	Development and use of Beta WRSF	Potential interaction	This activity will occur within the headwaters of Halfway Creek. Potential effects may result from erosion and sedimentation, atmospheric deposition, leaching of nitrogen residues generated from blasting, leaching of disturbed mine materials/waste, or groundwater and surface water interactions and seepage. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, physical parameters, nutrients, and total and dissolved metals.
Stockpiles	O-11	Continued use of temporary organics stockpile for vegetation and topsoil	Potential interaction	See Activity C-7.
	O-12	Continued use of frozen soils storage area	Potential interaction	See Activity C-8.
	O-13	Continued use of ROM stockpile for temporary storage of ROM ore	Potential interaction	This activity will occur within the headwaters of Latte Creek. The ROM stockpile will be on a lined pad, with drainage collected from the pad and the routed to the process plant. Potential effects may result from atmospheric deposition, leaching of nitrogen residues generated from blasting, or leaching from ROM stockpile are anticipated to be localized (limited to the small footprint of the ROM stockpile area), which may affect surface water quality by elevating TSS and turbidity concentrations and associated total and dissolved metals.
Crusher System	O-14	Crusher operation	Negligible interaction	This activity will occur within the headwaters of Latte Creek. Changes to surface water quality from this activity, if any, resulting from atmospheric deposition are anticipated to be within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	O-15	Continued use of crushed ore stockpile	Negligible interaction	This activity will occur within the headwaters of Latte Creek. Changes to surface water quality from this activity, if any, resulting from atmospheric deposition, leaching of nitrogen residues generated from blasting, or leaching from ore are anticipated to be localized (limited to the small footprint of the ore stockpile) and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Heap Leach Facility	O-16	Continued staged HLF construction, including related water management structures and year-round operation	Potential interaction	See Activity C-12.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	O-17	Progressive closure and reclamation of HLF	Potential interaction	This activity will occur within the headwaters of Latte and Halfway creeks. Potential effects from closure and reclamation of the HLF are expected to be localized and may result from erosion and sedimentation or atmospheric deposition. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, nutrients, and total and dissolved metals. All contact water will be collected and recycled within the HLF through to the end of Operations phase, and three separate leak detection systems will be employed (horizontal wick drains under each collection ditch or berm, electrical leak location surveys, and monitoring wells adjacent to the pad) to allow for early detection and remedy of any potential leak. Potential effects to surface water quality associated with leaching are not expected.
Plant Site	O-18	Process plant operation	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.
	O-19	Continued on-site use of processing reagents	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.
	O-20	Continued on-site use of diesel fuel or LNG	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.
Camp Site	O-21	Continued use of facilities	Potential interaction	Changes to surface water quality from the discharge of camp wastewater may elevate levels of nutrients (total P, ammonia, nitrite, and nitrate), biological oxygen demand, and chemical oxygen demand. Such increases may affect surface water quality by contributing to eutrophication and hypoxia/anoxia in the receiving environment.
Bulk Explosive Storage Area	O-22	Continued on-site use of explosives	Potential interaction	The onsite use of explosives has the potential to interact with surface water quality from the leaching of nitrogen residues generated from blasting activities in pit development, and groundwater and surface water interactions and seepage. These interactions may affect surface water quality by elevating levels of ammonia and nitrogen.
Mine Site and Haul Roads	O-23	Use and maintenance of mine site service roads and haul roads	Potential interaction	See Activity C-22
Site Water Management Infrastructure	O-24	Continued use of sedimentation ponds and conveyance structures	Potential interaction	This activity will occur within the headwaters of Latte, YT-24 and Halfway Creeks. Potential effects may result from erosion and sedimentation, atmospheric deposition, leaching of nitrogen residues generated from blasting (if required for construction), or groundwater and surface water interactions and seepage. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, nutrients, and total and dissolved metals.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	O-25	Ongoing use of site contact water (i.e., precipitation, stored rainwater) as HLF process water	No interaction	See Activity C-25.
	O-26	Installation and operation of water treatment facility for HLF rinse water	Potential interaction	This activity will occur within the headwaters of Latte and Halfway creeks. Potential effects to surface water quality may result during construction of the facility from erosion and sedimentation, atmospheric deposition, or leaching of nitrogen residues from blasting (if required for construction), and during operation from leaching of (partially treated) HLF residues. Such interactions may affect surface water quality by elevating levels of TSS and turbidity, nutrients, cyanide species, and total and dissolved metals.
Ancillary Components	O-27	NAR road maintenance (e.g., aggregate re-surfacing, sanding, snow removal)	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation, or atmospheric deposition, are anticipated to be localized footprints and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	O-28	NAR vehicle traffic, including mobilization and re-supply of freight and consumables	Potential interaction	See Activity C-29.
	O-29	Operation and maintenance of barge landing sites on Stewart River and Yukon River	Negligible interaction	See Activity C-30.
	O-30	Barge traffic on Stewart River and Yukon River	Negligible interaction	See Activity C-31.
	O-31	Annual construction, operation, maintenance, and removal of Stewart River and Yukon River ice roads	Negligible interaction	See Activity C-32.
	O-32	Annual construction and operation of winter road on the south side of the Yukon River	Negligible interaction	See Activity C-33.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	O-33	Operation and maintenance of gravel air strips	Negligible interaction	Changes to surface water quality from this activity, if any, resulting from erosion and sedimentation, or atmospheric deposition are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	O-34	Air traffic	No interaction	See Activity C-36.
	O-35	Use of all laydown areas	Negligible interaction	See Activity C-37.
	O-36	Use of Coffee Exploration Camp	No interaction	See Activity C-38.
Reclamation and Closure Phase (Year 13 through Year 23)				
Overall Mine Site	R-1	Reclamation of disturbed areas within mine site footprint	Potential interaction	This activity will occur within the headwaters of Latte, YT-24 and Halfway creeks. Potential effects may result from erosion and sedimentation, or atmospheric deposition, Surface water quality may be affected by elevated TSS and turbidity concentrations and associated total and dissolved metals.
	R-2	Excavation of contaminated soils followed by on-site treatment or temporary storage and off-site disposal	Potential interaction	See Activity O-2.
Open Pits	R-3	Reclamation of Double Double pit, Latte pit, Supremo pit, and Kona pit	Potential interaction	See Activities O-6 and O-7.
Waste Rock Storage Facilities	R-4	Reclamation of Alpha WRSF	Potential interaction	This activity will occur with the headwaters of Halfway Creek. Potential effects to surface water quality may result from erosion and sedimentation, or atmospheric deposition. Such interactions may affect surface water quality by elevating levels of TSS and turbidity and associated total and dissolved metals.
	R-5	Reclamation of Beta WRSF	Potential interaction	Since Kona pit is backfilled at the cessation of mining with waste material from Beta WRSF, this activity involves the reclamation of the WRSF footprint within the headwaters of Halfway Creek. Potential effects to surface water quality may result from erosion and sedimentation, or atmospheric deposition. Such interactions may affect surface water quality by elevating levels of TSS and turbidity and associated total and dissolved metals.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
Stockpiles	R-6	Reclamation of temporary organics stockpile, frozen soils storage area, and ROM stockpile	Potential interaction	This activity will occur within the headwaters of Halfway and Latte creeks. Potential effects to surface water quality may result from erosion and sedimentation, or atmospheric deposition. Such interactions may affect surface water quality by elevating levels of TSS and turbidity and associated total and dissolved metals.
Crusher System	R-7	Dismantling and removal of crusher facility	Potential interaction	This activity will occur within the headwaters of Latte Creeks. As the ore stockpile will be depleted by the end of the Operations phase, potential effects to surface water quality may result from erosion and sedimentation, or atmospheric deposition, during dismantling activities, or leaching from ore (including nitrogen residues). Such interactions may affect surface water quality by elevating levels of TSS and turbidity, physical parameters, nutrients (ammonia and nitrogen), and total and dissolved metals.
Heap Leach Facility	R-8	Closure of HLF and related water management structures	Potential interaction	See Activity O-17.
Plant Site	R-9	Dismantling and removal of process plant, reagent storage area, laboratory, truck shop and warehouse building, power plant, and bulk fuel storage	Negligible Interaction	It is anticipated that any concrete foundations will remain *in situ*. Changes to surface water quality from this activity, if any, are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Camp Site	R-10	Dismantling and removal or dormitories and kitchen, dining, and recreation complex buildings, mine dry and office complex, emergency response and training building, fresh (potable) water and fire water systems, sewage treatment plant, and waste management building	Negligible Interaction	Changes to surface water quality from this activity, if any, are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
Bulk Explosive Storage Area	R-11	Dismantling and removal of explosives storage facility	Potential interaction	This activity will occur on the height of land between the Latte and YT-24 drainages. Changes to surface water quality may result from erosion and sedimentation, atmospheric deposition, of leaching of nitrogen residues from stored explosives Such interactions may affect surface water quality by elevating levels of TSS and turbidity concentrations, physical parameters, nutrients, and total and dissolved metals.
Mine Site and Haul Roads	R-12	Decommissioning and reclamation of mine site service roads and haul roads	Potential interaction	This activity will occur throughout the Mine Site. Changes to surface water quality may result from erosion and sedimentation, or atmospheric deposition. Such interactions may affect surface water quality by elevating levels of TSS and turbidity concentrations, physical parameters, nutrients, and total and dissolved metals.
Site Water Management Infrastructure	R-13	Decommissioning and reclamation of selected water management infrastructure, construction of long-term water management infrastructure, including water deposition to creek systems	Negligible interaction	Changes to surface water quality from this activity, if any, are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	R-14	Operation and maintenance of HLF water treatment facility	Potential interaction	This activity will occur within the headwaters of Latte and Halfway Creeks. Potential effects may result from the release of (partially treated) HLF residues that may affect surface water quality by elevating levels of cyanide species, nutrients, and total and dissolved metals.
	R-15	Decommissioning and removal of HLF water treatment facility	Negligible interaction	Changes to surface water quality from this activity are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Ancillary Components	R-16	NAR road maintenance (e.g., aggregate re-surfacing, sanding, snow removal)	Negligible Interaction	See Activity O-27.
	R-17	NAR vehicle traffic	Potential interaction	See Activity C-29.

Project Component	Project Activities		Interaction Rating	Nature of Interaction and Potential Effect
	#	Description		
	R-18	Operation and maintenance of barge landing sites on Stewart River and Yukon River	Negligible Interaction	See Activity C-30.
	R-19	Annual resupply of consumables and materials for active closure via barge on the Yukon River	Negligible Interaction	See Activity C-31.
	R-20	Annual construction, maintenance, and decommissioning of Stewart River and Yukon River ice roads	Negligible interaction	See Activity C-32.
	R-21	Decommissioning of new road portions	Potential interaction	This activity will overlap spatially with watercourses that cross the newer sections of the NAR. Potential effects may result from erosion and sedimentation, atmospheric deposition, or leaching from disturbed material, which may result in elevated TSS and turbidity, physical parameters, nutrients, and/or total and dissolved metals.
	R-22	Air traffic	No interaction	See Activity C-36.
	R-23	Decommissioning and reclamation of airstrip	Negligible Interaction	Changes to surface water quality from this activity, if any, are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
	R-24	Re-opening and operation of pre-existing Yukon River exploration camp and airstrip to support post-closure monitoring activities	Negligible Interaction	This activity will occurs near Coffee Creek. Changes to surface water quality from this activity, if any, are anticipated to be localized and within existing ranges of surface water quality indicators. Since any effects are expected to be negligible, this activity is not considered further in this assessment.
Post-closure Phase (Year 24 onwards)				
Overall Mine Site	P-1	Long-term monitoring	No interaction	An interaction between this activity and surface water quality is not anticipated. This activity is not considered further in this assessment.

4.2 POTENTIAL PROJECT-RELATED EFFECTS

This section considers potential adverse Project-related effects to surface water quality arising from potential interactions identified in **Table 4.1-2**. Project interactions that are expected to result in no potential effect or a negligible potential effect (identified as 'no interaction' and 'negligible interaction' in **Table 4.1-2**, respectively) are not carried forward for assessment. Negligible potential effects are those effects before the implementation of mitigation that are so small that they are not detectable or measurable and are not anticipated to influence surface water quality.

The sections below describe the mechanism by which the Project interactions listed in **Table 4.1-2** may affect surface water quality. As stated previously in **Section 4.1**, descriptions of potential effects provided below are qualitative, and residual effects to surface water quality based on quantitative changes (predicted using the water balance model) are described in **Section 4.4**.

4.2.1 EROSION AND SEDIMENTATION

Erosion and sedimentation associated with surface disturbances may result in potential Project-related adverse effects to surface water quality during all Project phases. The geographic extent of effects from erosion and sedimentation events may range from localized to far-reaching, depending on the amount and type of particulate materials introduced into the aquatic receiving environment, and the nature of the erosion source.

As summarized in **Table 4.1-2**, potential Project-related sources of erosion and sedimentation during the Construction phase include:

1. Mobilization of mobile equipment and construction materials
2. Clearing, grubbing, and grading of areas to be developed within the mine site
3. Material handling
4. Development of Latte pit and Double Double pit and dewatering of pits (as required)
5. Development and use of Alpha WRSF, temporary organics stockpile for vegetation and topsoil, frozen soils storage area, and run-of-mine (ROM) stockpile
6. Staged heap leach facility (HLF) construction, including associated event ponds, rainwater pond, piping, and water management infrastructure
7. Construction of storage facilities for explosives components and on-site use of explosives
8. Upgrade, construction, and maintenance of mine site service roads and haul roads
9. Development and use of sedimentation ponds and conveyance structures
10. Upgrade of existing road sections and construction of new road sections for the Northern Access Route (NAR), including installation of culverts and bridges
11. Vehicle traffic, including mobilization and re-supply of freight and consumables
12. Construction, operation, and maintenance of permanent bridge over Coffee Creek and gravel airstrips

Potential Project-related sources of erosion and sedimentation within the mine site area during the Operations phase include:

- Material handling
- Excavation of contaminated soils followed by on-site treatment or temporary storage and off-site disposal
- Progressive reclamation of disturbed areas within mine site footprint
- Development of Kona pit and Supremo pit and continued development of Double Double pit and Latte pit, and dewatering of pits (as required)
- Continued development and use of Alpha WRSF, and development and use of Beta WRSF
- Continued use of temporary organics stockpile and frozen soils storage area
- Continued staged HLF construction, including related water management structures and year-round operation
- Progressive closure and reclamation of HLF, and Installation and operation of water treatment facility for HLF rinse water
- Use and maintenance of mine site service roads and haul roads
- Continued use of sedimentation ponds conveyance structures, and
- NAR vehicle traffic, including mobilization and re-supply of freight and consumables

Potential Project-related sources of erosion and sedimentation within the mine site area during the Reclamation and Closure phase include:

13. Reclamation of disturbed areas within mine site footprint
14. Excavation of contaminated soils followed by on-site treatment or temporary storage and off-site disposal
15. Reclamation of Alpha WRSF and Beta WRSF footprint
16. Reclamation of temporary organics stockpile, frozen soils storage area, and ROM stockpile
17. Dismantling and removal of crusher facility and stockpile area
18. Closure of HLF and related water management structures
19. Dismantling and removal of explosives storage facility
20. Decommissioning and reclamation of mine site service roads and haul roads
21. NAR vehicle traffic, and
22. Decommissioning of new road portions

During the Post-closure phase, no activities are planned (with the exception of monitoring) within the Project area. Nevertheless, because the closed mine site overlaps with the headwaters of Latte, YT-24 and Halfway creeks, potential interactions resulting from erosion and sedimentation may occur. Potential effects to surface water quality from this interaction and the interactions described above for the Construction and Operations phases are assessed further.

This mechanism has potential to increase levels of turbidity, TSS, and total and dissolved metals in surface water receiving environments, negatively affecting surface water quality, and possibly linked receptors (e.g., fish and fish habitat, wildlife and wildlife habitat). High-velocity lotic systems, including Project-area creeks and the Yukon River, are expected to recover from the effects of erosion and sedimentation quicker than slower-moving systems because particulates are expected to remain in suspension and be carried downstream. Creeks and the Yukon River have naturally-elevated sediment loads during spring freshet, although TSS are typically low throughout the rest of the year. When background TSS levels are low, potential effects from sedimentation/erosion may be greater, particularly in low-gradient depositional zones (e.g., eddies or oxbows) that may incur a higher degree of sedimentation.

4.2.2 LEACHING FROM DISTURBED MINE MATERIALS/WASTE

Leaching from disturbed mine materials/waste is expected to occur as a consequence of Project development through the disturbance, excavation, crushing, and storing of geologic materials (e.g., bedrock). An assessment of the potential for acid rock drainage (ARD) resulting from the Project indicates that most rock types have little or no potential for acid generation, with the exception of ore from the Kona pit. Most leachate chemistry will reflect weathering associated neutral rock drainage. Further information on geologic materials, geochemistry and expected leaching rates is presented in **Appendix 12-D**.

The geographic extent of effects resulting from mine materials/waste leachate depends on several factors, including the nature and type of geologic material, the loading rate of leachate products to contact water, the discharge rate of contact water to the receiving environment, and the background concentration of the same products in receiving streams. Lower levels of geologic leaching are expected in association with NAR development compared to the Mine Site area, given the small relative fraction of bedrock that will be disturbed to upgrade and develop roadways. For example, a total of 300 Mt of waste rock and 60.1 Mt of ore will be excavated from open pits at the mine site and stored in the heap leach facility or in waste rock storage facilities. In contrast, borrow material requirements for road construction that will be sourced along the road alignment are estimated at approximately 0.56 Mt. Given that the mass of rock disturbed at the Mine Site is more than 500 times greater than disturbances associated with the NAR road alignment, the potential effects associated with the excavation of geologic material are primarily associated with the Mine Site area.

Potential Project-related sources of leaching products from disturbed mine materials/waste during the Construction phase include:

1. Dewatering of pits (as required)
2. Development and use of Alpha WRSF, frozen soils storage area, and run-of-mine (ROM) stockpile
3. Upgrade of existing and construction of new road sections for the NAR, including installation of culverts and bridges, and
4. Construction, operation, and maintenance of permanent bridge over Coffee Creek

During the Operations phase, potential Project sources of leaching products from disturbed materials/waste include:

1. Development of Kona pit and Supremo pit and continued development of Double Double pit and Latte pit, followed by cessation of mining at all pits
2. Partial backfill of Latte pit and Supremo pit, backfill of Double Double pit and Kona pit, and dewatering of pits (as required)
3. Continued development and use of Alpha WRSF and development and use of Beta WRSF, and
4. Continued use of frozen soils storage area and ROM stockpile.

Potential Project-related sources of leaching products from disturbed mine materials/waste during the Reclamation and Closure phase include:

1. Reclamation of Double Double pit, Latte pit, Kona pit, and Supremo pit
2. Dismantling and removal of crusher facility and stockpile, and
3. Decommissioning of new road portions

During the Post-closure phase, no mining-related activities associated with the Project will occur. Nevertheless, because the closed mine site overlaps with the headwaters of Latte, YT-24 and Halfway creeks, long-term sources of mine materials/waste leachate, such as reclaimed WRSFs or back-filled pits, have potential to alter receiving environments. Potential effects to surface water quality from this interaction and the interactions described above for the Construction and Operations phases are assessed further.

Leachate from mine materials and waste is expected to result in elevated levels of physical parameters or elevated total and dissolved metals in contact waters, including runoff and seepage from waste rock dumps, the ore stockpile, the overburden stockpile, and exposed pit surfaces. Contact water has the potential to adversely affect surface water quality, as well as linked pathway receptors (e.g., fish and fish habitat, wildlife and wildlife habitat).

4.2.3 NITROGEN LEACHING FROM BLASTING RESIDUES

Residues from nitrogen-based explosive use (blasting) will remain on the surfaces of newly blasted materials, including waste rock, exposed bedrock, pit walls, and unprocessed ore. The mass of nitrogen residues accumulated on these surfaces will vary depending on nitrogen management practices, blasting conditions (e.g., wet vs. dry), and the volume and type of explosives used. Because these residues are highly soluble, they will readily dissolve and elevate levels of nitrogen species ammonia, nitrite, and nitrate in contact waters.

The geographic extent of effects from blasting residues depends largely on the loading rate to the receiving environment. In addition to nitrogen management practices, the loading rate to the environment will depend on the degree to which blasting is required to support the development of mine infrastructure, facilities, and the NAR. Lower nitrogen loading is expected in association with NAR development compared to development in the Mine Site area, given the relatively small amount of blasting required during NAR construction.

Potential Project-related sources of blasting-related nitrogen residues during the Construction phase may include:

1. Development of Latte pit and Double Double pit, and dewatering of pits (as required)
2. Development and use of Alpha WRSF
3. Construction of storage facilities for explosives components and on-site use of explosives
4. Development and use of sedimentation ponds and conveyance structures
5. Upgrade of existing and construction of new road road sections for the NAR, including installation of culverts and bridges
6. Construction, operation, and maintenance of permanent bridge over Coffee Creek

During the Operations phase, potential Project-related sources of blasting-related nitrogen residues include:

1. Development of Kona pit and Supremo pit and continued development of Double Double pit and Latte pit, followed by cessation of mining at all pits
2. Partial backfill of Latte pit and Supremo pit, backfill of Double Double pit and Kona pit, and dewatering of pits (as required)
3. Continued development and use of Alpha WRSF, and development and use of Beta WRSF
4. Continued use of ROM stockpile
5. Continued on-site explosives
6. Continued use of sedimentation ponds conveyance structures, and
7. Installation and operation of water treatment facility for HLF rinse water

Potential Project-related sources of blasting-related nitrogen residues during the Reclamation and Closure phase include:

1. Reclamation of Double Double pit, Latte pit, Kona pit, and Supremo pit, and
2. Dismantling and removal of crusher facility and stockpile area, and explosives storage facility.

No mining-related explosive use is anticipated for the Project during the Post-closure phase. Nevertheless, long-term leaching of nitrogen residues associated with reclaimed blasted materials, such as reclaimed WRSFs and back-filled pits, may occur. Potential effects to surface water quality from this interaction and the interactions described above for the Construction and Operations phases are assessed further.

Unmanaged discharge of blasting residue-influenced contact water to the receiving environment has the potential to affect surface water quality and linked pathway receptors (e.g., fish and fish habitat, wildlife and wildlife habitat). Potential effects will depend upon the load discharged in a specific area and catchment. High concentrations of ammonia, nitrite, and nitrate in the receiving environment have the potential to cause toxicity to sensitive receptors (e.g., juvenile fish). Similarly, high nitrogen loading to streams, when paired with sufficient phosphorus (P) loading, has potential to decrease surface water quality through eutrophication, thereby reducing habitat quality. Surface water quality may be affected to a lesser degree by a small relative increase in ammonia and nitrate concentrations during the open water season, as aquatic resources may be enhanced by the increase (i.e., the increase could stimulate primary producer growth and enriching benthic invertebrate and fish habitat).

4.2.4 Leaching of Heap Leach Facility Residues

Residues leached from the HLF and the associated water treatment facility may include cyanide, nutrients and total and dissolved metals. Most cyanide used through mine life will be captured and/or treated (degraded) as specified in the mine plan and HLF design. Some residues may remain on HLF materials and subsequently leach to the receiving environment following decommissioning of the HLF and water treatment facility. In addition, nitrogen-based nutrients may result from the degradation of cyanide, occurring as ammonia, nitrite, and chiefly nitrate, while total P may be associated with leachate and/or discharge from the HLF water treatment facility. HLF contact waters are also expected to contain elevated levels of certain metals associated with cyanide, which are subsequently dissociated once cyanide breakdown occurs.

The geographic extent of potential effects from HLF residues will depend on the loading rate to the receiving environment and the effectiveness of HLF water treatment facility during the Reclamation and Closure phase. Note that potential spills from HLF operation (e.g., cyanide from the process circuit) are not anticipated, unless as a result of an accident or malfunction, and will be avoided, minimized and managed through implementation of standard BMPs (refer to **Section 6.0**).

No Project-related sources of HLF residues are identified for the Construction phase. During the Operations and Reclamation and Closure phases, the operation of HLF water treatment facility has the potential to affect surface water quality.

During the Post-Closure phase, no mining-related activities associated with the Project will occur. Nevertheless, because the closed mine site overlaps with the headwaters of Latte, YT-24 and Halfway creeks, long-term sources of HLF residues have the potential to leach into receiving environment. . Potential effects to surface water quality from this interaction and the interactions described above for the Construction and Operations phases are assessed further.

Unmanaged discharge of contact water from the HLF has potential to affect surface water quality. Effects will depend on the chemistry of the contact water and total load discharged. As discussed above, a small relative increase to nutrient levels in Project area creeks during the open water season has the potential to enhance aquatic habitat. Alternatively, higher relative concentrations of nitrogen-based nutrients, alongside elevated levels of cyanide and/or total and dissolved metals, have the potential to reduce water quality and cause toxic effects to aquatic receptors.

4.2.5 GROUNDWATER AND SURFACE WATER INTERACTIONS AND SEEPAGE

Project activities have the potential to alter groundwater and surface water hydrological regimes, thereby potentially altering surface water quality. The baseline surface water quality dataset shows that the interaction between groundwater and surface water plays an important role in determining natural water chemistry. For example, the annual concentration signature for several parameters (most notably U) in certain Project area creeks is driven by the groundwater baseflow, which dominates the hydrograph during winter low flow months. Groundwater quality and quantity is discussed in further detail in Section 7.0 and Appendix 7-B. and hydrology in Section 8.0 and Appendix 8-B.

Potential Project-related interactions between groundwater and surface water during the Construction phase include development and use of Alpha WRSF, and sedimentation ponds and conveyance structures, and dewatering of pits (as required). During the Operations phase, potential Project-related interactions between groundwater and surface water include:

1. Development of Kona pit and Supremo pit and continued development of Double Double pit and Latte pit, followed by cessation of mining at all pits, and dewatering of pits (as required)
2. Partial backfill of Latte pit and Supremo pit, and backfill of Double Double pit and Kona pit
3. Development and use of Beta WRSF
4. Continued on-site use of explosives, and
5. Continued use of sedimentation ponds conveyance structures

Potential Project-related interactions during the Reclamation and Closure phase include the reclamation of Double Double pit, Latte pit, Kona pit, and Supremo pit. During the Post-Closure phase, no mining-related activities associated with the Project will occur. Nevertheless, Project-related interactions between surface and groundwater may continue as the closed mine site overlaps with the headwaters of Latte, YT-24 and Halfway creeks. Long-term seepage of Project-affected groundwater to surface water receptors may occur. Potential effects to surface water quality from this interaction and the interactions described above for the Construction and Operations phases are assessed further.

Unmanaged seepage from WRSFs, pits, stockpiles, and disturbed areas may transport leaching products associated with disturbed mine materials/waste, blasting, or the HLF to surface waters, increasing concentrations of physical parameters, nutrients, and total and dissolved metals.

4.2.6 Atmospheric Deposition

Air-borne dust is anticipated to be generated from surface disturbance, blasting, vehicle traffic, earthworks, culvert and bridge installation along the NAR, and other mining activities. Deposition of dust in receiving environments has the potential to affect surface water quality during all mine phases. For further information on air quality emissions, refer to Section 9.0 and Appendix 9-B.

During the Construction phase, potential Project-related sources of dust include:

1. Mobilization of mobile equipment and construction materials
2. Clearing, grubbing, and grading of areas to be developed within the mine site
3. Material handling
4. Development of Latte pit and Double Double pit
5. Development and use of Alpha WRSF, temporary organics stockpile for vegetation and topsoil, frozen soils storage area, and run-of-mine (ROM) stockpile
6. Staged heap leach facility (HLF) construction, including associated event ponds, rainwater pond, piping, and water management infrastructure
7. Construction of storage facilities for explosives components and on-site use of explosives
8. Upgrade, construction, and maintenance of mine site service roads and haul roads
9. Development and use of sedimentation ponds and conveyance structures
10. Upgrade of existing road sections and construction of new road sections for the Northern Access Route (NAR), including installation of culverts and bridges
11. Vehicle traffic, including mobilization and re-supply of freight and consumables
12. Construction, operation, and maintenance of permanent bridge over Coffee Creek and gravel airstrips

Potential Project-related sources of dust during the Operations phase include:

- Material handling
- Excavation of contaminated soils followed by on-site treatment or temporary storage and off-site disposal
- Progressive reclamation of disturbed areas within mine site footprint
- Development of Kona pit and Supremo pit and continued development of Double Double pit and Latte pit
- Continued development and use of Alpha WRSF, and development and use of Beta WRSF
- Continued use of temporary organics stockpile, ROM stockpile
- Continued staged HLF construction, including related water management structures and year-round operation
- Progressive closure and reclamation of HLF, and Installation and operation of water treatment facility for HLF rinse water
- Use and maintenance of mine site service roads and haul roads
- Continued use of sedimentation ponds conveyance structures
- NAR vehicle traffic, including mobilization and re-supply of freight and consumables

Potential Project-related sources of dust during the Reclamation and Closure phase include:

1. Reclamation of disturbed areas within mine site footprint
2. Excavation of contaminated soils followed by on-site treatment or temporary storage and off-site disposal
3. Reclamation of Alpha WRSF and Beta WRSF footprint
4. Reclamation of temporary organics stockpile, frozen soils storage area, and ROM stockpile
5. Dismantling and removal of crusher facility and stockpile area
6. Closure of HLF and related water management structures
7. Dismantling and removal of explosives storage facility
8. Decommissioning and reclamation of mine site service roads and haul roads
9. NAR vehicle traffic
10. Decommissioning of new road portions

Project-related dust-generation is expected to be decrease with the cessation of Project activities at the onset of Post-Closure. Nevertheless, aerial deposition of Project-related dust may continue through the early Post-Closure period until ground cover is re-established on the former Project footprint. Potential effects to surface water quality from this interaction and the interactions described above for the Construction and Operations phases are assessed further.

Deposition of dust has the potential to affect surface water quality by increasing concentrations of TSS, turbidity, and total and dissolved metals.

4.3 Mitigation Measures

This section describes mitigation measures consistent with the definition provided by YESAA (i.e., measures for the elimination, reduction, or control of adverse environmental or socio-economic effects). Mitigation measures comprise any practical means taken to manage potential effects to surface water quality from Project development, operation and closure, and may include Project design elements, management plans, monitoring and adaptive management, and application of specific standards, guidelines, and BMPs, where relevant.

Several mitigation measures relevant to surface water quality are incorporated into the Project design and mine plan to eliminate or reduce effects to the extent possible. These include a combination of Project phasing and development schedules, waste handling options, and water management infrastructure and planning commitments, as summarized in the sections below. Details on mitigative measures to avoid effect through Project Design and planning are further discussed in Section 2.9 (Project Alternatives and Chosen Approach) of the Project Proposal. In concert with Project design mitigations, the implementation of BMPs and management plans, paired with monitoring and adaptive management, will further reduce potential effects to surface water quality through the Project life.

In addition to reducing direct effects to surface water quality, several mitigations presented below are also intended to mitigate potential effects to ICs that represent pathways of effect to surface water quality, most notably groundwater and hydrology (see Sections 7.0 and 8.0 of the Project Proposal, respectively).

Key measures relevant to the mitigation of Project-related effects to surface water quality are summarized in sections below. Mitigation measures are described in relation to the Project phase in which they will be implemented and the specific Project component and activity.

4.3.1 Phased Mine Development and Progressive Reclamation

Phased mine development and progressive reclamation of the mine site area represent a primary design mitigation eliminating, reducing, or controlling for potential effects to surface water quality.

Phased development of the mine site area will reduce pre-stripping requirements in the early years. This will minimize the spatial and temporal extent of surface disturbance, and ultimately changes to water quality from sedimentation and erosion and weathering of disturbed mine materials. Progressive reclamation and closure activities will begin as soon as mining at the Double Double pit has been completed and will continue throughout the Operations phase. Additional benefits of this approach include providing flexibility in the schedule, maximizing ore grade, and allowing the HLF to be maintained at full production capacity.

With respect to the HLF, phased development and progressive reclamation has been incorporated throughout the facility's design in order to reduce potential surface water quality effects. For example, the heap leach pad design is based on staged construction with initial capacity of approximately 6 Mt expanding to the ultimate capacity of 60 Mt in five stages. Further, the pad will be lined, in order to collect process and rinse solutions and protect surface and groundwater quality through the operating life and after HLF closure (mitigation measure proposed for this facility are described further in **Section 3.3.1.3**). Progressive reclamation of the heap leach pad will entail rinsing of individual sections of the heap leach ore once they have undergone the complete gold recovery cycle. The heap will be rinsed and capped in stages and as each stage is capped, the raincoats (i.e., exposed geomembrane covers) for that area will be removed and used in other areas or incorporated as part of the closure capping.

The Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) outlines guidance and best practices for reclamation of the mine site area, including the removal of infrastructure, waste rock pile re-contouring, and decommissioning of sedimentation ponds and sumps, ditches, and roads. Implementation of this plan will further minimize potential effects to surface water quality.

4.3.2 Management of Explosives Use and Blasting

Leaching of nitrogen residues to surface waters from nitrogen-based explosives will be minimized by observing best practices for blasting. The export of nitrogen from blasting is directly linked to the type and quantities of explosives used, and the blasted surface contact water flow rate, volume and management. The specific processes leading to the release of nitrogen and the distribution of water soluble nitrogen species to the environment are difficult to quantify and predict. They can include incomplete combustion, miss fires, microbial activity, and variation in all of these for each blast.

Blasting will be conducted throughout the Construction and Operation phases in association with NAR construction and with mine site area development, including pit development. Explosives use will follow BMPs, Project management plans and technical guidance documents to minimize the generation of nitrogen residues and leaching of residues to surface waters, including:

- Waste Rock and Overburden Management Plan (Appendix 31-D of the Project Proposal) –outlines best practices, management and mitigation measures for nitrogen-based explosives use for rock blasting and contact water management
- Access Route Construction Management Plan (Appendix 31-A of the Project Proposal) – presents mitigation measures for explosives use that may occur near surface waters along the NAR, and
- Guidelines for Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998) – establishes guidelines for explosives use in and around fish habitat.

4.3.3 WASTE ROCK MANAGEMENT

Several mitigation measures will be implemented for the management of waste rock generated as part of NAR and Mine Site area development. Exposed waste rock has potential to leach geochemical weathering products and nitrogen residues from blasting to surface water and groundwater that eventually report to the receiving environment. Therefore, waste rock will be managed so as to minimize potential effects to surface water quality, including long-term storage of waste rock in storage facilities (i.e., WRSFs) or backfilling waste rock into pits. A small amount of waste rock may be potentially acid generating (PAG), most notably from the Kona Pit; in addition to the waste rock management measures described in this section, PAG materials are prescribed specific mitigations to address Metal Leaching (ML) and Acid Rock Drainage (ARD), which are discussed further in **Section 4.3.4**.

The Alpha and Beta WRSF sites were selected to meet geotechnical and mine design criteria and will be engineered to minimize operational and closure costs and reduce long-term environmental effects. Management measures will minimize effects to surface water quality associated with sedimentation and erosion, leaching of from disturbed materials/waste, groundwater/surface water interactions, and atmospheric deposition during the Construction and Operation phases. In addition to Project design measures, implementation of BMPs and Project management plans will mitigate potential effects associated with waste rock. Project-wide details on waste rock management are presented in the Waste Rock and Overburden Management Plan (Appendix 31-D of the Project Proposal), which further prescribes mitigation measures to minimize potential effects to surface water.

Waste rock will be used to backfill mined out pits at Kona, Double-Double, portions of Supremo, and portions of Latte. Additional backfill will be considered once Goldcorp determines that such backfill will not sterilize economical resources. Backfilling will have the additional benefit of creating causeways that shorten the ore haul distance to the crusher (compared to having to haul material around the pits). Backfilling will occur during the Operations phase, and will minimize potential effects associated with sedimentation and erosion, leaching from disturbed materials/waste, groundwater/surface water interactions, and atmospheric deposition.

A small amount of waste rock is anticipated from NAR development; this waste rock will be managed according to the Access Route Construction Management Plan (Appendix 31-A of the Project Proposal) and the Access Route Operational Management Plan (Appendix 31-B of the Project Proposal), which include details on rock placement, water management and monitoring for potential disturbance effects along the NAR.

The Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) provides guidance and best practices for waste rock management specific to the closure of facilities. Proposed mitigation includes revegetation, where possible, and reclamation of WRSFs, including pit backfilling, WRSF re-contouring, and re-establishment of natural surface water flow paths (e.g., via decommissioning of sedimentation pond, sumps, and ditches that previously captured WRSF contact water).

4.3.4 MANAGEMENT OF POTENTIAL ARD

Several design mitigations are incorporated into the mine plan to minimize effects associated with potential ARD, which can result in elevated levels of physical parameters, and total and dissolved metals reporting to surface water. Mitigations include management of ML/ARD-generating materials/waste from the Kona Pit, management of potential ARD at the HLF, and management of potential ARD in the ROM stockpile.

The Kona Pit is the only pit that has ARD potential, where ARD is associated with the ore. Therefore, all ore and associated leachate from this pit will be processed and contained within the HLF to prevent ore contact waters from discharging to the receiving environment prior to treatment. Although waste rock from Kona Pit does not have ARD potential, there is potential for residual ore to be exposed on the pit walls. Water that collects within Kona Pit will be therefore pumped out for use as process make-up water during Operations. Waste rock generated from pit development will be placed in the temporary Beta WRSF adjacent to the pit during mining and then backfilled into the mined pit once mining activities cease. This will ensure that the pit will be backfilled with non-potentially acid generating (non-PAG) waste rock at closure. As the mine plan moves into detailed design, other methods of closure, including filling the Kona Pit with water may also be considered.

To reduce ARD potential of ore in the HLF (i.e., 1.6% of HLF mass), crushed ore will be mixed with lime (to increase pH) and non-PAG rock in the heap leach feed conveyor during heap loading operation. This approach is planned to minimize acid generation, and reduce leaching of metals. This mitigation will occur during the Operations phase.

In addition to Project design mitigations, the following management plans will be applied to project activities to mitigate potential effects to surface water quality:

- Metal Leaching/Acid Rock Drainage Management Plan (currently in development for project licensing) – describes ML/ARD monitoring and prevention strategies for the Project, as well as reporting requirements and contingency options that may be implemented, if needed.
- Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) — outlines approach and best practices for reclamation and closure of the Project, including mitigations to minimize potential long-term effects associated with ML/ARD.

4.3.5 PROCESSING FACILITIES MITIGATIONS AND WATER MANAGEMENT

Various mitigation measures are incorporated into the Project design for processing facilities to minimize effects to surface water quality. These mitigations primarily relate to the HLF, including the integration of progressive reclamation activities during facility operation, the water balance, non-contact water management, event ponds, a rainwater storage pond, and a water treatment facility for the HLF. Each component is described in further detail below.

Foremost, the HLF design will facilitate progressive closure, thereby minimizing the volume and duration of disturbed materials. The pad will be constructed in five stages, separated into cells, and closed progressively. Final closure design will allow for site transition to passive management for Post-closure.

The HLF water balance will be operated through all mine phases to minimize demand for withdrawal of make-up water from external sources and to avoid the need to treat surplus water until near the end of the mine life. Process water for use in heap pad leaching will be primarily sourced from site contact water, thereby minimizing the need to withdraw water from area.

During the Construction and Operations phases, surface water and rainwater will be kept away from the HLF pad and process circuit to the maximum extent possible through the following measures:

- Installation of permanent and interim perimeter diversion channels and berms around the perimeter of the heap leach pad.
- Installation of a drainage ditch or berm and drainage pipe between each heap leach stage, and between cells within each stage by construction of a ditch or berm with a drainage pipe every 100 m. These berms and ditches will allow high-resolution tracking of solution chemistry and aid in progressive closure by allowing rinsing of older portions of the heap leach pad beginning in Year 4.
- Starting in or before Year 3, placement of raincoats over portions of the heap leach pad to minimize infiltration of rainwater and snowmelt into the heap and process circuit, and to increase heat retention in the winter, and
- Progressive closure of HLF, reducing the length of time that the HLF is at its maximum footprint size.

In parallel with non-contact water management components, two event ponds (EP-1S and EP-1N) will be built between the heap leach pad and the process plant in Year -1 prior to commencement of operations. These ponds, to be in use over the life of mine, will be capable of containing seasonal water accumulation, full heap drainage, the 24-hour “Probable Maximum Precipitation” (PMP) storm event, and seasonal solution accumulation. Each pond will have three synthetic liner layers: a double HDPE geomembrane, separated by a leak detection and collection layer, and underlain by a Geosynthetic Clay Liner (GCL).

A third event pond, EP-2, will be built in an adjacent location and placed in service in or before Year 6 to accommodate the expanded heap leach pad footprint. The pond will be sized to contain a PMP storm event, complete heap drainage, and maximum seasonal water accumulation, plus additional freeboard), in excess of industry standards and regulatory requirements. It will be used only in response to a PMP event (i.e., highly diluted solution). EP-2 will have 2 geosynthetic liners: an HDPE liner over a GCL.

A rainwater storage pond, capable of being converted to an event pond, if necessary, will be built between the HLF and the process plant in or before Year 3 of Operations. The pond, which will receive only clean water, will have two geosynthetic liners: an HDPE liner over a GCL.

Lastly, a water treatment facility will be installed and operational in Year 9 in order to treat surplus water from the HLF. This mitigation will reduce parameters in contact water associated with leaching from HLF residues, explosives residues, and disturbed mine materials, prior to discharge to the receiving environment. This will occur near the end of the Operations phase and through the Reclamation/Closure phase.

Various management plans outline best practices and guidance relevant to processing facilities, including:

- Spill Contingency Plan (currently in development for project licensing) — details operational procedures, contingency plans, and mitigation and management measures related to spills to minimize potential effects to surface water quality.
- Water Management Plan (Appendix 31-E of the Project Proposal)— describes the water management for the Project area, including infrastructure design, construction, inspections, maintenance, and monitoring for potential effects to water quality
- Heap Leach Process Facilities Management Plan (currently in development for project licensing) — outlines operational procedures and management of heap leach facilities, including BMPs to mitigate potential effects to surface water quality during facility operations (including progressive reclamation), and facility decommissioning and closure.
- Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) — outlines operational procedures and management of heap leach facilities, including best practices to mitigate potential effects to surface water quality during facility decommissioning and closure.
- Cyanide Management Plan (currently in development for project licensing) — outlines operational procedures, contingency plans, and best practices related to cyanide use in heap leaf facility to minimize potential effects to surface water quality.

4.3.6 SURFACE WATER AND GROUNDWATER PROTECTION AND MANAGEMENT

Potential leaching or exchange of contaminants from surface water and groundwater interactions will be minimized through specific Project design mitigations.

With respect to surface waters, the design and sizing of the WRSFs will be adjusted to reflect the hydrology of their corresponding drainages and to direct WRSF contact waters to sedimentation ponds. For example, waste rock benches will be designed to slope inwards from WRSF crest. Runoff will be concentrated along the toe of each bench and prevented from running over the WRSF face through a series of diversion berms. Runoff will be diverted to the perimeter of the WRSFs and collected in channels at the WRSF perimeter. Minor runoff volumes may be directed down the WRSF face via a variation of channels and berm cuts. Interim water management structures will be built, as required. Effects to surface water quality from leaching of disturbed mine materials and groundwater/surface water interactions will be minimized through these measures.

Mitigation measures for groundwater protection and management are relevant to surface water quality (as describe in **Section 4.2.6**) and are included here.

To minimize potential effects associated with the ROM stockpile, the drainage will be collected and used as process make-up water to minimize contact water that reports to the receiving environment.

Potential effects will be further mitigated through guidance and best practices prescribed in the following documents:

- Water Management Plan (Appendix 31-E of the Project Proposal) — describes the water management for the Project area, including infrastructure design, construction, inspections, maintenance, and monitoring for potential effects to surface water quality
- Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) — provides guidance and best practices for revegetation and reclamation of habitat for future wildlife use, including the removal of infrastructure, WRSF re-contouring, and decommissioning of sedimentation ponds, sumps, ditches, and roads.

In contrast with the mine site area, limited interaction is anticipated between surface and groundwater along the NAR. Potential effects will be mitigated through guidance and best management practices presented in Access Route Construction Management Plan (Appendix 31-A of the Project Proposal) and Access Route Operational Management Plan (Appendix 31-B of the Project Proposal).

4.3.7 Mine Site Area Water Management

Extensive water management facilities are integrated into the Project design and serve to mitigate potential effects to surface water quality (Figure 2.2-2). These facilities are designed to collect and manage all run-off generated within the Project area, including contact and non-contact waters, prior to discharge to the receiving environment. These facilities will minimize potential effects resulting from erosion and sedimentation, groundwater and surface water interactions and seepage.

Water management facilities will consist of a network of surface drainage channels and ponds through the Construction, Operations, and Reclamation and Closure phases. Drainage channels will be capable of conveying a 100-year 24-hour storm event, including average daily snowmelt.

Drainage channels will route runoff from the Camp/Plant site to the Facility Pond located downstream (**Figure 2.2-2**). All runoff, WRSF infiltration and other water in the basin up-gradient of the Alpha WRSF will report to the Alpha Pond via the rock underdrain. The ponds will serve two purposes: 1) settlement of TSS load prior to discharge (i.e., erosion and sedimentation), and 2) attenuation of peak discharge rates associated with runoff from storm events through storage and release.

Both of the sediment retention ponds will be sized to store and release a volume of water equal to or less than the 10-year, 24-hour storm event runoff volume for up to 48 hours and an average daily snowmelt volume for up to approximately 12 hours. Each pond will be lined to reduce seepage (i.e., surface and groundwater interactions). Sediment pond outlet structures will accommodate flows up to the 100-year 24-hour storm event. Emergency spillways will be capable of conveying the 200-year, 24-hour storm event (a larger event may be considered upon further evaluation of the ponds).

Starting in the construction phase, best practices prescribed in the Water Management Plan (Appendix 31- E of the Project Proposal) will be applied to minimize effects to water quality. Reclamation and closure methods for water management facilities outlined in the Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) will mitigate potential effects to surface water quality associated with these activities.

4.3.8 EROSION AND SEDIMENTATION CONTROL

Potential effects to surface water quality associated with erosion and sedimentation will be mitigated through the implementation of the Sediment and Erosion Control Plan (currently in development for project licensing). This plan prescribes guidance and best practices to minimize sedimentation and erosion associated with the NAR and Mine Site area development including, but not limited to:

- Minimization of surface disturbance, including clearing and grubbing
- Management of runoff from disturbed areas through grading slopes, ditching, and sedimentation ponds/sumps
- Progressive reclamation of disturbed surfaces, including revegetation.

The mine plan incorporates various design mitigation measures that minimize potential effects associated with erosion and sedimentation. For example, exposed surfaces and slopes within the Project area will be engineered so as to minimize potential for erosion. Backfilling of pits during the Operations phase will further minimize potential sedimentation and erosion by reducing the hauling distance (and thus road traffic) on mine site area roads. Additionally, accommodations and the office complex will consist of portable, modular units constructed off-site to reduce site disturbance that would be associated with construction and decommissioning (thereby reducing potential for sedimentation and erosion).

The Conceptual Reclamation and Closure Plan (Appendix 31-C of the Project Proposal) presents best practices alongside Project design mitigations to minimize potential for erosion and sedimentation associated with reclamation and closure activities (e.g., reclamation of disturbed areas, dismantling of infrastructure, and decommissioning of water management structures).

With respect to NAR development, upgrades, and alignment, potential sedimentation and erosion will be mitigated through best practices and guidance outlined in the Access Route Construction Management Plan (Appendix 31-A of the Project Proposal) and Access Route Operational Management Plan (Appendix 31-B of the Project Proposal).

4.3.9 Dust Management

Potential effects to surface water quality due to fugitive dust will be managed and mitigated as described in the Dust Management Plan (currently in development for project licensing).

Project activities, like vehicle traffic, hauling, surface works and disturbance, construction, blasting, crushing, NAR development and upgrades, and progressive reclamation, will follow best practices to minimize fugitive dust that could deposit into surface waters. Fugitive dust will be monitored as part of the air quality monitoring program, described further in Appendix 9-B (Air Quality and Greenhouse Gas Emissions IC Report) of the Project Proposal.

Through Construction, Operation, and Reclamation and Closure phases, vehicle traffic along the NAR will be minimized to reduce dust, thereby mitigating local effects to surface water quality associated with sedimentation and erosion, and atmospheric deposition. Most site personnel will operate on a 2 week on – 2 week off-shift rotation on a fly-in – fly-out basis. Atmospheric deposition of dust associated with the NAR will be further mitigated using best practices and guidance outlined in the Access Route Construction Management Plan (Appendix 31-A) and Access Route Operational Management Plan (Appendix 31-B).

4.3.10 Monitoring and Adaptive Management

Environmental monitoring programs will be implemented to detect potential Project-related changes to surface water quality, including monitoring of surface water quality, surface hydrology, and groundwater flow and quality. These data will also verify the accuracy of water quality modelling predictions presented in the Project Proposal, and will determine the need to implement adaptive management. Water quality monitoring data for creeks in the Project area and Yukon River will be compared to baseline water quality data, PSSWQOs, and CCME and BC WQGs for the protection of aquatic life. An unexpected increase in certain parameter concentrations above these thresholds may indicate a Project-related effect, requiring further investigation or adaptive management. Further details on the surface water quality effects monitoring and adaptive management program are presented in **Section 7.0**.

Adaptive management represents an integral part of the program to effectively implement mitigation, BMPs, monitoring plans, and management plans. These components may be updated as the Project progresses based on Project changes and site specific conditions. Management plans presented in Project Proposal Appendices 31-A to 31-F provided further detail on adaptive management strategies specific to each plan.

4.3.11 SUMMARY OF MITIGATION MEASURES

As listed above, the mitigation measures incorporated into the Project design are extensive, and in concert, they serve to substantially reduce potential Project-related effects to surface water quality. In addition to the various mitigation measures listed above, monitoring and management plans (see **Section 8.0**) will inform the day-to-day operation of the site and associated water management activities. The objective of the proposed monitoring network is to track the movement and storage of water on the site, the rates and points of discharge, and the monitoring thresholds that will trigger additional mitigative (i.e., adaptive) action to reduce the effects of the Project on surface water quality in a timely manner.

Table 4.3-1summarizes mitigation measures proposed to eliminate or reduce potential effects associated with Project components and activities by mine phase and includes a determination of whether a residual effect is anticipated following the implementation of mitigation measures. Residual effects have been determined based on qualitative evaluations of the anticipated effectiveness of mitigation measures. Further assessment based on quantitative predictions determined through modelling of the residual effects identified in **Table 4.3-1** is provided in **Section 4.4.2**.

Table 4.3-1 Summary of Potential Effects and Mitigation Measures for Surface Water Quality

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Construction Phase				
Erosion and sedimentation – potential increased concentrations of turbidity, TSS, and total and dissolved metals in surface water quality	Overall Mine Site	Mobilization of equipment and materials Clearing, grubbing, and grading Material handling	Erosion and sedimentation control Phased mine development and progressive reclamation Mine Site area water management Monitoring and adaptive management	No
	Open Pits	Development of Latte and Double Double pits, and pit dewatering as required	Erosion and sedimentation control (i.e., around pits; sedimentation is not expected from pits as sediments will have settled prior to dewatering) Phased mine development and progressive reclamation Waste rock management Mine Site area water management Monitoring and adaptive management	
	WRSFs	Development and use of Alpha WRSF	Erosion and sedimentation control Phased mine development and progressive reclamation Waste rock management Mine Site area water management Monitoring and adaptive management	
	Stockpiles	Development and use of temporary organics stockpile, frozen soils storage area, ROM stockpile	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	
	Heap Leach Facility (HLF)	Staged HLF construction, including related water management structures	Erosion and sedimentation control Processing facilities mitigations and water management (e.g., design mitigations for non-contact water management around the HLF include non-contact diversion channels and berms) Monitoring and adaptive management	

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	Bulk Explosive Storage Area	Construction of storage facilities and on-site use of explosives	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	
	Mine Site and Haul Roads	Upgrade, construction, and maintenance of mine site service roads and haul roads	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	
	Site Water Management Infrastructure	Development and use of site water management structures	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	
	Ancillary Components	Upgrade and construction of NAR road sections and crossing structures Vehicle traffic Construction, operation and maintenance of Coffee Creek Bridge Construction and maintenance of gravel airstrips	Erosion and sedimentation control (e.g., road design mitigations and use of silt fences, check dams and other measures, as appropriate) Monitoring and adaptive management	
Leaching from disturbed mine materials / waste – potential increased concentrations of physical parameters and total and dissolved metals in surface water quality	Open Pits	Dewatering of pits (as required)	Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	WRSFs	Development and use of Alpha WRSF	Phased mine development and progressive reclamation Waste rock management Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	Stockpiles	Development and use of frozen soils storage area and ROM stockpile	Phased mine development and progressive reclamation Waste rock management Management of potential ARD (ROM and crushed ore may include materials from the Kona pit that could be PAG) Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	No
	Ancillary Components	Upgrade and construction of NAR road sections and crossing structures Construction, operation and maintenance of Coffee Creek Bridge	Erosion and sedimentation control Waste rock management Monitoring and adaptive management	No
Leaching of nitrogen residues from blasting – potential increased concentrations of ammonia, nitrite, and nitrate in surface water quality	Open Pits	Development of Latte and Double Double pits, and pit dewatering (as required)	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	WRSFs	Development and use of Alpha WRSF	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	
	Stockpiles	Development and use of frozen soils storage area and ROM stockpile	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	Bulk Explosive Storage Area	Construction of storage facilities and on-site use of explosives	Management of explosives use and blasting (if blasting is required) Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	Site Water Management Infrastructure	Development and use of site water management structures	Management of explosives use and blasting (if blasting is required) Mine Site area water management Monitoring and adaptive management	No
	Ancillary Components	Upgrade and construction of NAR road sections and crossing structures Construction, operation and maintenance of Coffee Creek Bridge	Erosion and sedimentation control Management of explosives use and blasting (if blasting is required) Mine Site area water management Monitoring and adaptive management	No
Discharge of camp wastewater – potential increased eutrophication and hypoxia/anoxia in the receiving environment.	Camp Site	Construction and operation of camp and administrative facilities, and discharges of camp wastes	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	No
Groundwater and surface water interactions and seepage – potential increased concentrations of	Open Pits	Dewatering of pits (as required)	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**No**

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
physical parameters, nutrients, and total and dissolved metals in surface water quality	WRSFs	Development and use of Alpha WRSF	Surface water and groundwater protection and management Phased mine development and progressive reclamation Waste rock management Mine site area water management Monitoring and adaptive management	**Yes**
	Site Water Management Infrastructure	Development and use of site water management structures	Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	No
Atmospheric deposition – potential increased concentrations of TSS, turbidity, and total and dissolved metals in surface water quality	Overall Mine Site	Mobilization of equipment and materials Clearing, grubbing, and grading Material handling	Dust management Monitoring and adaptive management	No
	Open Pits	Development of Latte and Double Double Pits		
	WRSFs	Development and use of Alpha WRSF		
	Stockpiles	Development and use of temporary organics stockpile, frozen soils storage area, and ROM stockpile		
	HLF	Staged HLF construction, including related water management structures		
	Bulk Explosive Storage Area	Construction of storage facilities and on-site use of explosives		
	Mine Site and Haul Roads	Upgrade, construction, and maintenance of mine site service roads and haul roads		
	Site Water Management Infrastructure	Development and use of site water management structures		

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	Ancillary Components	Upgrade and construction of NAR road sections and crossing structures Vehicle traffic Construction, operation and maintenance of Coffee Creek Bridge Construction and maintenance of gravel airstrips		
Operation Phase				
Erosion and sedimentation – potential increased concentrations of turbidity, TSS, and total and dissolved metals in surface water quality	Overall Mine Site	Material handling Excavation of contaminated soils Progressive reclamation of disturbed areas	Erosion and sedimentation control Phased mine development and progressive reclamation Mine Site area water management Monitoring and adaptive management	No
	Open Pits	Development of pits, and dewatering (as required)	Erosion and sedimentation control Phased mine development and progressive reclamation Waste rock management Mine Site area water management Monitoring and adaptive management	
	WRSF	Development and/or use of Alpha and Beta WRSFs	Erosion and sedimentation control Phased mine development and progressive reclamation Waste rock management Mine Site area water management Monitoring and adaptive management	
	Stockpiles	Use of temporary organics stockpile and frozen soils storage area	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	HLF	Continued staged HLF construction and operation, including related water management structures Progressive closure and reclamation	Erosion and sedimentation control Phased mine development and progressive reclamation Processing facilities mitigations and water management Monitoring and adaptive management	
	Mine Site and Haul Roads	Use and maintenance of mine site service roads and haul roads	Erosion and sedimentation control Mine Site area water management Monitoring and adaptive management	
	Site Water Management Infrastructure	Continued use of site water management structures Installation and operation of HLF water treatment facility	Erosion and sedimentation control Phased mine development and progressive reclamation Mine Site area water management Monitoring and adaptive management	
	Ancillary Components	NAR Vehicle traffic – mobilization and re-supply of freight and consumables	Erosion and sedimentation control Monitoring and adaptive management	
Leaching from disturbed mine materials / waste – potential increased concentrations of physical parameters and total and dissolved metals in surface water quality	Open Pits	Development of Kona, Supremo, Double Double and Latte pits End of mining at all pits Partial backfill of Latte, Supremo pits Backfill of Double Double, Kona pits Dewatering of pits (as required)	Waste rock management Management of potential ARD (i.e., for Kona waste rock) Phased mine development and progressive reclamation Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	WRSFs	Development and/or use of Alpha and Beta WRSFs	Waste rock management Management of potential ARD (i.e., for Kona waste rock) Phased mine development and progressive reclamation Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	Stockpiles	Use of frozen soils storage area and ROM stockpile	Management of potential ARD Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	No
Discharge of camp wastewater – potential increased eutrophication and hypoxia/anoxia in the receiving environment.	Camp Site	Continued use of facilities, including discharges of camp wastes.	Mine Site area water management Monitoring and adaptive management	No
Leaching of HLF residues – potential increased concentrations of nitrogen-based nutrients, cyanide and total and dissolved metals in surface water quality	Site Water Management Infrastructure	Installation and operation of HLF water treatment facility	Erosion and sedimentation control Phased mine development and progressive reclamation Processing facilities mitigations and water management Mine Site area water management Monitoring and adaptive management	**Yes**

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Leaching of nitrogen residues from blasting – potential increased concentrations of ammonia, nitrite, and nitrate in surface water quality	Open Pits	Development of Kona, Supremo, Double Double and Latte pits End mining at all pits Partial backfill of Latte, Supremo pits Backfill of Double Double, Kona pits Dewatering of pits (as required)	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	WRSFs	Development and/or use of Alpha and Beta WRSFs	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	Stockpiles	Continued use of ROM stockpile	Management of explosives use and blasting Surface water and groundwater protection and management (i.e., leaching may occur from ore) Monitoring and adaptive management	**Yes**
	Bulk Explosive Storage Area	Continued on-site use of explosives	Management of explosives use and blasting Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	**Yes**
	Site Water Management Infrastructure	Continued use of site water management structures	Management of explosives use and blasting Mine Site area water management Monitoring and adaptive management	**Yes**

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Groundwater and surface water interactions and seepage - – potential increased concentrations of physical parameters, nutrients, and total and dissolved metals in surface water quality	Open Pits	Development of Kona, Supremo, Double Double and Latte pits End mining at all pits Partial backfill of Latte, Supremo pits Backfill of Double Double, Kona pits Dewatering of pits (as required)	Waste rock management Surface water and groundwater protection and management Mine Site area water management Phased mine development and progressive reclamation Monitoring and adaptive management	**Yes**
	WRSFs	Development and/or use of Alpha and Beta WRSFs	Waste rock management Management of potential ARD (i.e., for of Kona waste rock) Surface water and groundwater protection and management Mine site area water management Phased mine development and progressive reclamation Monitoring and adaptive management	**Yes**
	Bulk Explosive Storage Area	Continued on-site use of explosives	Phased mine development and progressive reclamation Surface water and groundwater protection and management Processing facilities mitigations and water management Mine Site area water management Monitoring and adaptive management	**Yes**
	Site Water Management Infrastructure	Continued use of site water management infrastructure	Phased mine development and progressive reclamation Surface water and groundwater protection and management Mine Site area water management Monitoring and adaptive management	No

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Atmospheric deposition – potential increased surface water quality concentrations of TSS, turbidity, and total and dissolved metals in surface water quality	Overall Mine Site	Material handling Excavation of contaminated soils Progressive reclamation of disturbed areas	Dust management Monitoring and adaptive management	No
	Open Pits	Development of pits		
	WRSF	Development and/or use of Alpha and Beta WRSFs		
	Stockpiles	Use of temporary organics stockpile and ROM stockpile		
	HLF	Continued staged HLF construction and operation, including related water management structures Progressive closure and reclamation		
	Mine Site and Haul Roads	Use and maintenance of mine site service roads and haul roads		
	Site Water Management Infrastructure	Continued use of site water management structures Installation and operation of HLF water treatment facility		
	Ancillary Components	NAR Vehicle traffic – mobilization and re-supply of freight and consumables		

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Reclamation and Closure Phase				
Erosion and sedimentation – potential increased concentrations of turbidity, TSS, and total and dissolved metals in surface water quality	Overall Mine Site	Reclamation of disturbed areas Excavation of contaminated soils	Erosion and sedimentation control Processing facilities mitigations and water management Mine Site area water management Monitoring and adaptive management	No
	WRSFs	Reclamation of Alpha and Beta WRSFs		
	Stockpiles	Reclamation of temporary organics stockpile, frozen soils storage area, and ROM stockpile		
	Crusher System	Dismantling and removal of crusher facility and stockpile		
	HLF	Closure of HLF and related water management structures		
	Bulk Explosive Storage Area	Dismantling and removal of explosives storage facility		
	Mine Site and Haul Roads	Decommissioning and reclamation of mine site service roads and haul roads		
	Ancillary Components	NAR vehicle traffic Decommissioning of new road sections		

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Leaching from disturbed mine materials / waste - potential increased concentrations of physical parameters and total and dissolved metals in surface water quality	Open Pits	Reclamation of Double Double pit, Latte pit, Kona pit, and Supremo pit	Waste rock management Management of potential ARD Mine Site area water management Monitoring and adaptive management	**Yes**
	Crusher System	Dismantling and removal of crusher facility and stockpile	Processing facilities mitigations and water management (all ore at crusher stockpile will be transferred to HLF during Operations phase; HLF water will be treated as drain down occurs) Mine Site area water management Monitoring and adaptive management	No
	Ancillary Components	Decommissioning of new road sections	Waste rock management Erosion and sedimentation Monitoring and adaptive management	No
Leaching of nitrogen residues from blasting - potential increased concentrations of ammonia, nitrite, and nitrate in surface water quality	Open Pits	Reclamation of Double Double pit, Latte pit, Kona pit, and Supremo pit	Management of explosives use and blasting (best practices employed in earlier phases will minimize nitrogen leaching from pit walls and backfilled waste rock) Mine Site area water management Monitoring and adaptive management	**Yes**
	Crusher System	Dismantling and removal of crusher facility and stockpile	Management of explosives use and blasting (best practices employed in earlier phases will minimize nitrogen leaching from pit walls and backfilled waste rock)Processing facilities mitigations and water management (nitrogen residues in ROM stockpile area will be treated once stockpile is transferred to HLF). Mine Site area water management Monitoring and adaptive management	No

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
	Bulk Explosive Storage Area	Dismantling and removal of explosives storage facility	Management of explosives use and blasting (any unused explosives will be handled and disposed of as per regulatory requirements). Mine Site area water management Monitoring and adaptive management.	No
Leaching of HLF residues – potential increased concentrations of nitrogen-based nutrients, cyanide and total and dissolved metals in surface water quality	Site Water Management Infrastructure	Operation and maintenance of HLF water treatment facility	Management of explosives use and blasting (best practices employed in earlier mine phases will minimize nitrogen leaching). Processing facilities mitigations and water management (all drainage from HLF will be treated) Mine Site area water management Monitoring and adaptive management	**Yes**
Groundwater and surface water interactions and seepage - potential increased concentrations of physical parameters, nutrients, and total and dissolved metals in surface water quality	Open Pits	Reclamation of Double Double pit, Latte pit, Kona pit, and Supremo pit	Surface water and groundwater protection and management (surface and groundwater interaction in Kona and Supremo pits will be minimized by permafrost). Management of potential ARD Mine Site area water management Monitoring and adaptive management	**Yes**

Summary of Potential Effect by Mechanism	Project Components	Contributing Project Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect (Yes / No)
Atmospheric deposition - potential increased surface water quality concentrations of TSS, turbidity, and total and dissolved metals in surface water quality	Overall Mine Site	Reclamation of disturbed areas Excavation of contaminated soils	Dust management Monitoring and adaptive management	No
	WRSFs	Reclamation of Alpha and Beta WRSFs		
	Stockpiles	Reclamation of temporary organics stockpile, frozen soils storage area, and ROM stockpile		
	Crusher System	Dismantling and removal of crusher facility and stockpile		
	HLF	Closure of HLF and related water management structures		
	Bulk Explosive Storage Area	Dismantling and removal of explosives storage facility		
	Mine Site and Haul Roads	Decommissioning and reclamation of mine site service roads and haul roads		
	Ancillary Components	NAR vehicle traffic Decommissioning of new road sections		

4.4 Residual Effects and Significance of Residual Effects

This section describes the residual effects of the Project to surface water quality that are anticipated to occur after the implementation of mitigation measures described above in **Section 4.3**. The significance of residual effects are also presented. The assessment of residual effects described in this section incorporates quantitative predictions from the WBM. Future conditions with the Project (referred to in WBM outputs as the Base Case) are compared to future baseline conditions (referred to in WBM outputs as the Natural Case). As both future cases incorporate the predicted influence of climate change, a comparison of the Base Case to the Natural Case represents Project-related changes.

Overall, the following mechanism are predicted to cause residual effects to surface water quality in the Mine Site Area:

- Leaching from disturbed mine materials/waste
- Discharge of camp water
- Leaching of nitrogen residues generated from blasting
- Leaching of HLF residues, and
- Groundwater and surface water interactions and seepage.

Residual effects to surface water quality are not expected to occur along the NAR, or due to erosion and sedimentation, or atmospheric deposition. The mechanisms listed above (i.e., activities that have the potential to result in residual effects to surface water quality) were incorporated into the WBM to predict changes to surface water quality indicators (i.e., 25 water chemistry parameters including anions, nutrients and metals) in the Project area (refer to **Section 2.0** for further detail). A predicted change to water quality was subsequently evaluated as a potential residual effect. The WBM incorporated the mine plan and mine plan design mitigations.

Potential residual effects to surface water quality in the Project area (i.e., Base Case conditions) were compared to the modelled Natural Case conditions, which are considered to represent conservative conditions in terms of flow conditions and geochemical source terms. The WBM generated predictions for 25 indicators of potential residual Project effects for key locations within the receiving environment (model nodes) on a mean monthly basis for the life of mine. Of the 25 indicators modelled, those reflecting a Project–related change are categorized according to standard effect characteristics and ratings and the significance of the residual effect for each affected indicator is determined (refer to **Section 4.4.1.1** below).

The following sections outline how the characteristics and significance of residual effects are defined (**Section 4.4.1**), followed by a discussion of the water quality results and residual effects identified in each of the main catchments (**Section 4.4.2**). A summary of the Project-related residual adverse effects and significance is provided in the final section (**Section 4.4.3**).

4.4.1 Residual Effects Characteristics and Significance Definitions

4.4.1.1 Residual Effects Characteristics

The residual effect characteristics used to evaluate predicted Project-effects to surface water quality are summarized in this section. The significance definition for residual effects is described in the following section.

As described in **Section 2.3**, water quality predictions were initially compared to CCME or BC long-term WQG for the protection of freshwater aquatic life. These guidelines are derived to be protective of all species and life stages of aquatic life occurring in Canada or BC; therefore, it is expected that predicted concentrations that do not exceed a WQG will not have an adverse effect to aquatic life. If the predicted concentration of a parameter exceeded its corresponding BC or CCME guideline, the parameter was carried forward to the residual effects assessment and residual effects associated with the predicted concentration were evaluated and characterized using criteria presented below.

Potential Project-related residual effects are qualitatively characterized in terms of direction, magnitude, geographic extent, timing, frequency, duration, reversibility, and probability of occurrence. The definition and rating criteria for each effect characteristic are summarized in **Table 4.4-1**, and described in greater detail below.

Table 4.4-1 Effect Characteristics Considered When Determining the Significance of Residual Effects to Surface Water Quality

Residual Effect Characteristic	Definition	Rating
Direction	Identifies whether the residual effect will be adverse or positive	• Adverse • Positive
Magnitude	Size or severity of the residual effect	• Low • Moderate • High
Geographic Extent	Spatial scale over which the residual effect is expected to occur	• Project Area • Local Assessment Area • Regional Assessment Area
Timing	Temporal occurrence of the residual effect.	• Open-water period • Ice-cover period • Year-round
Frequency	How often the residual effect is expected to occur within a given period identified under Timing.	• Single event • Multiple irregular event Multiple regular event • Continuous

Residual Effect Characteristic	Definition	Rating
Duration	Length of time over which the residual effect is expected to persist	• Short-term • Medium-term • Long-term
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases	• Fully reversible • Irreversible
Probability of occurrence	Likelihood that the predicted residual effect will occur.	• Likely • Unlikely
Context	The potential ecological sensitivity to the residual effect, and the ability of the system/receptor to recover from that effect.	• Low • Moderate • High

Direction characterizes the residual effect to surface water quality as adverse or positive. An effect resulting in elevated metal concentrations that could potentially cause toxicity to aquatic organisms would be considered adverse. Conversely, a slight increase in nutrients predicted to increase stream productivity (but not eutrophication) may be characterized as positive.

Magnitude reflects the expected size or severity of the residual effect to surface water based on the following three rating levels:

- Low: Small measurable increase from model Natural Case; prediction is <50% above corresponding WQG and falls below PSSWQO (if applicable)
- Moderate: Moderate measurable increase from Natural Case; prediction is less than 2-times the corresponding WQG or irregularly exceeds the PSSWQO (if applicable). A low risk of adverse effect to aquatic receptors is inferred to due to:
  - Low availability of dissolved (and thus more toxic) parameter species
  - Conservatism of screening benchmarks (WQG or PSSWQO)
  - Consideration of other toxicological factors (e.g., ameliorative factors such as hardness) and ecological factors (e.g., presence/absence of sensitive species or life-stages).
- High: Large measurable increase from Natural Case; prediction is greater than 2-times the corresponding WQG or regularly exceeds the PSSWQO (if applicable). A higher potential of adverse effects to aquatic receptors is inferred due to consideration of other toxicological (e.g., ameliorative factors such as hardness) and ecological factors (e.g., presence of species of concern).

Geographic extent characterizes the spatial scale within which the predicted residual effect is likely to occur:

- Project area: Occurring only at a single modelling node within a specific catchment, and/or limited to part of the catchment
- Local Assessment Area: Occurring along the length of the entire catchment mainstem for Latte Creek, Coffee Creek, YT-24, and Halfway Creek, downstream of the Project

- Regional Assessment Area: Occurring in Yukon River.

Timing reflects its temporal occurrence within a year. For the purposes of the surface water quality assessment, effect timing was characterized as occurring within one of three periods:

- Open-water: Occurring within the months of April to October, generally reflecting the spring/summer growing period
- Ice-cover: Occurring within the months of November through to March, and
- Year-round: most or all months of the year.

Frequency characterizes the number of times during the Project or a specific Project phase that the effect occurs:

- Infrequent: Occurs once during any Project phase
- Multiple irregular event: Occurs sporadically at irregular intervals (e.g., one-in-ten year low-flow event)
- Multiple regular event: Occurs on a regular basis and at regular intervals throughout the Project (e.g., during freshet or winter low-flow periods); and
- Continuous: Occurs continuously during any Project phase.

The residual effect Duration indicates the length of time over which the residual effect is expected to persist, categorized as:

- Short-term: Effect occurs for one month over the course of one year
- Medium-term: Effect occurs seasonally or over the course of several months of one year; and
- Long-term: Effect persists beyond one year.

An effect's Reversibility indicates whether the residual effect is likely to be reversed once the activity ceases. More specifically:

- Fully reversible: Concentrations of Project-affected parameters in surface water quality will return to baseline conditions
- Partially reversible: Concentrations of Project-affected parameters in surface water quality will return to levels at which residual effects are not expected, but do not return to baseline levels; and
- Irreversible: Residual effect will not be reversed.

The Probability of Occurrence indicates whether a predicted residual effect is likely or unlikely to occur:

- Likely: There is a high level of certainty that the effect will occur based on conservative assumptions used in the predictive water quality model, as well as baseline datasets for the Project, current understanding of the receiving environment, available scientific literature, an assumed level of effectiveness of mitigation measures, and past project experience; and
- Unlikely: These is a high level of uncertainty that the predicted effect will occur.

In general, the present assessment evaluates the water quality model Base Case, reflecting the expected or most likely outcome for geochemical source terms, surface and groundwater hydrology, and climate conditions. Therefore, a “likely” rating was assigned to each residual effect unless certain aspects of water quality modelling predictions were associated with significant uncertainty.

Lastly, Context reflects the potential ecological sensitivity of the system to the residual effect, including the relative sensitivity of the resident aquatic community, and its ability to recover from that effect. This definition also includes the consideration of previous activities in the area, for example if the environment was adversely affected by previous human activities and/or other project developments. Context was rated as high, moderate or low:

- High: Area is pristine or has high ecological value (for example, fish spawning grounds) and has not been subject to any previous disturbance by human activities, so that the system is considered to have low resilience and is likely highly sensitive to the predicted effect
- Moderate: The system has neutral resilience and is considered moderately sensitive to the predicted effect, (e.g. the area has been adversely affected by previous human activities, but the level of disturbance is considered relatively low), and
- Low: The system is considered resilient and likely has low sensitivity to the predicted effect (e.g. it has been adversely affected by previous human activities and/or other project developments).

4.4.1.2 Significance Definition

The overall residual effects to each modelled catchment area were assigned a significance rating as a means of ranking potential effects to Project area surface water quality. The significance of each residual effect was rated as follows:

Significant Residual effects characterized as Significant are carried forward to the cumulative effects assessment. Significant effects are those with the following combination of characteristics:

Direction – Adverse

Magnitude – High

Geographic extent – LAA or RAA

Timing – Open-water period, ice-cover period, or year-round

Frequency – Multiple regular event or continuous

Duration – Long-term or permanent

Reversibility – Fully reversible or irreversible

Probability of occurrence – Likely

Context – High

Not Significant Residual effects were considered Not Significant if they demonstrated any other combination of effect characteristics than those used to define a Significant rating.

Each Significant or Not Significant rating was assigned a confidence level of Low, Medium, or High, based on the confidence in the information supporting the effects characteristics ratings. This supporting information included:

- Scientific certainty relative to the quantification of the effect, including assumptions used in the water quality model (**Section 2.0**), the baseline surface water quality dataset (**Section 3.0**), or the current level of understanding of potential effects (status of science);
- The degree of conservatism built into WQGs;
- The current level of understanding of the Project receiving environment (e.g., occurrence of sensitive species, life stages, and habitat); and
- Professional judgment based on prior experience in predicting effects and the known effectiveness of proven mitigation measures.

4.4.2 Residual Effects

The assessment evaluates potential residual effects to surface water quality based on the predicted concentrations of key indicators (**Section 1.3**) under Base Case model conditions (presented in Appendix 12-C). The results presented in this section support the assessment of potential residual effects to pathway VCs linked to surface water quality, including, but not limited to, fish and fish habitat, vegetation, wildlife and wildlife habitat, and birds and bird habitat.

The Base Case water quality model results incorporate conservative assumptions with respect to the derivation of source terms, climate considerations and geochemical behaviour along groundwater pathways, or in the receiving environment. As part of the assessment methodology, predicted mean monthly concentrations for each parameter were compared to their corresponding BC or CCME water quality guideline for the protection of aquatic life. Aquatic life guidelines reflect the most sensitive water use for Project area streams and were thus selected for screening purposes over other guidelines (e.g., drinking water, wildlife/livestock or irrigation/agriculture). Water quality parameters with concentrations predicted to fall below guidelines were screened out of the assessment for residual effects, since the guidelines approved by CCME and the BC Ministry of Environment are considered protective of all aquatic species and life stages. Predicted concentrations were also compared to a Natural Case (i.e., no Project) to account for parameters which have naturally-elevated background concentrations.

An overview of the Base Case water quality predictions is presented in the sections below, followed by a detailed characterization and assessment of residual effects for each parameter exceeding relevant water quality guidelines (or upper trigger range values in the case of phosphorus) within the individual Project-area catchments and specified locations within the Yukon River. The results are presented as compared to the Natural Case, reflecting baseline mean monthly concentrations. If the predicted exceedance is not attributed to background, the parameter is identified as a potential Project-related parameter of concern (POC). Each residual effect prediction is then described in terms of significance and likelihood, followed by a summary of the level of confidence associated with each prediction.

4.4.2.1 Water Quality Model Results Overview

An overview of the Base Case water quality modelling results in support of the determination of residual Project effects is presented in this section.

Water quality predictions for all modelled scenarios through all phases of the Project are presented in full in Appendix 12-C. For the purpose of identifying indicators of residual project effects, predicted maximum monthly values for all parameters at each receiving environment node are presented in **Table 4.4-1** for Project area creek stations and **Table 4.4-2** for Yukon River Stations. Values are compared to the relevant CCME or BC WQG (or trigger range upper limit in the case of phosphorus) and to the Natural (no Project) case. Maximum monthly values for all mine phases are shown (as opposed to the mean or another statistic) to identify all parameters that are predicted to exceed their WQG at any point in mine life.

Table 4.4-2 Predicted Maximum Monthly Concentrations for Project-Area Creek Stations for All Mine Phases

		CC1.5		CC3.5		Screening Level	CC4.5			HC2.5		HC5.0		Screening Level	YT24		
Parameter	Unit	Maximum Monthly Concentrations		Maximum Monthly Concentrations			Maximum Monthly Concentrations		Screening Level	Maximum Monthly Concentrations		Maximum Monthly Concentrations			Maximum Monthly Concentrations		Screening Level
		Base Case	Natural	Base Case	Natural	WQG	Base Case	Natural	WQG	Base Case	Natural	Base Case	Natural	WQG	Base Case	Natural	WQG
Ammonia	mg/L	0.0342	0.0344	0.0338	0.0343	1.63	0.0363	0.0365	1.90	0.0432	0.0384	0.0399	0.0399	1.91	0.030	0.030	1.91
NO3	mg/L	1.04	0.35	0.810	0.567	3	0.793	0.792	3	4.32	0.698	2.87	0.694	3	0.699	0.700	3
NO2	mg/L	0.00729	0.00500	0.0064	0.0050	0.02	0.00521	0.00500	0.02	0.0214	0.0050	0.0153	0.0050	0.02	0.0050	0.0050	0.02
SO4	mg/L	249	249	171	175	309	89.0	89.0	218	201	100	131	29.2	218	39.9	40.0	218
P	mg/L	0.0155	0.0139	0.0151	0.0144	0.1	0.0173	0.0173	0.1	0.0355	0.0158	0.0247	0.0163	0.1	0.0164	0.0147	0.1
WADCN	mg/L	0.00011	0.00001	0.00008	0.00001	0.005	0.000018	0.000010	0.005	0.00158	0.00001	0.0010	0.0000	0.005	0.000010	0.000010	0.005
D-Al	mg/L	0.261	0.265	0.256	0.270	0.05	0.312	0.315	0.05	0.268	0.282	0.281	0.291	0.05	0.0534	0.0554	0.05
Ag	mg/L	0.000012	0.000012	0.000011	0.000011	0.00025	0.0000149	0.0000149	0.00025	0.000018	0.000012	0.000013	0.000006	0.00025	0.000013	0.000012	0.00025
As	mg/L	0.00269	0.00180	0.00148	0.00124	0.005	0.000717	0.000636	0.005	0.0035	0.0016	0.00256	0.00162	0.005	0.00634	0.00067	0.005
Ca	mg/L	140	140	93.0	95.2	-	39.6	39.6	-	59.8	59.8	48.5	41.9	-	40.4	30.0	-
Cd	mg/L	0.000040	0.000041	0.000040	0.000041	0.00013	0.000040	0.000040	0.000119	0.000027	0.000028	0.000028	0.000029	0.00011	0.000015	0.000009	0.00010
Cr	mg/L	0.000751	0.000739	0.000742	0.000739	0.001	0.000720	0.000720	0.001	0.00134	0.00120	0.00127	0.00121	0.001	0.0005	0.0005	0.001
Cu	mg/L	0.00252	0.00254	0.00248	0.00253	0.002	0.00331	0.00333	0.002	0.00281	0.00294	0.00292	0.00302	0.002	0.0026	0.0027	0.002
Fe	mg/L	0.287	0.290	0.282	0.291	1.0	0.388	0.391	1.0	0.726	0.785	0.758	0.808	1.0	0.140	0.140	1.0
Hg	mg/L	0.000011	0.000011	0.000011	0.000011	0.000026	0.000011	0.000011	0.000026	0.000012	0.000011	0.000011	0.000011	0.000026	0.000008	0.000008	0.000026
Mg	mg/L	43.9	43.9	29.5	30.2	-	13.9	13.9	-	27.4	24.9	20.8	10.1	-	13.0	10.0	-
Mn	mg/L	0.0491	0.0492	0.0501	0.0513	0.966	0.0284	0.0283	0.917	0.0951	0.0564	0.0751	0.0583	0.891	0.0230	0.0050	0.856
Mo	mg/L	0.00525	0.00060	0.00318	0.00057	0.073	0.00115	0.000811	0.073	0.0269	0.0025	0.0174	0.0007	0.073	0.0059	0.0005	0.073
Ni	mg/L	0.00159	0.00160	0.0016	0.0016	0.082	0.00147	0.00148	0.0737	0.00176	0.00139	0.00158	0.00142	0.0689	0.0015	0.0015	0.061
Pb	mg/L	0.000293	0.000303	0.000295	0.000310	0.00247	0.000274	0.000275	0.00206	0.00031	0.00033	0.000318	0.000332	0.00184	0.00006	0.00006	0.0015
Sb	mg/L	0.00115	0.00020	0.000653	0.000153	0.009	0.000281	0.000226	0.009	0.00432	0.00120	0.00284	0.000451	0.009	0.00259	0.00040	0.009
Se	mg/L	0.000399	0.000399	0.000275	0.000281	0.002	0.000133	0.000129	0.002	0.00066	0.00016	0.00046	0.00008	0.002	0.00021	0.00012	0.002
Tl	mg/L	0.000033	0.000008	0.000021	0.000007	0.0008	0.000009	0.000007	0.0008	0.000146	0.000009	0.000096	0.000008	0.0008	0.00004	0.00001	0.0008
U	mg/L	0.0326	0.0319	0.0209	0.0213	0.015	0.00672	0.00638	0.015	0.0996	0.0996	0.0375	0.0225	0.015	0.0146	0.0010	0.015
Zn	mg/L	0.00543	0.00436	0.00497	0.00441	0.015	0.00456	0.00449	0.018	0.0156	0.0040	0.0107	0.0041	0.013	0.0032	0.0014	0.011

Notes:

Dark-shaded (Base Case) and light-shaded (Natural Case) cells represent concentrations that exceeds WQG

“Base Case" = model-predicted, mine-impacted water quality under expected or base case condition

"Natural Case" = model background case (no mine-impact); includes climate change effects

WQG = BC WQG or CCME WQG, based on guidelines identified in **Appendix 12-C-4**

All metals shown as total fraction. Dissolved guideline for Al shown

Hardness- and pH-dependent guidelines calculated using 25th P of baseline dataset for corresponding station

Table 4.4-3 Predicted Maximum Monthly Concentrations for Project-area Yukon River Stations for All Mine Phases compared to Generic Water Quality Guideline for Reference

Parameter	Unit	YRdsCC4.5 Maximum monthly concentrations		YRdsYT24 Maximum monthly concentrations		YRdsHC5.0 Maximum monthly concentrations		Screening Level
		Base Case	Natural	Base Case	Natural	Base Case	Natural	WQG
Ammonia	mg/L	0.0293	0.0294	0.0260	0.0260	0.0261	0.0261	1.02
NO3	mg/L	0.143	0.128	0.100	0.100	0.164	0.101	3
NO2	mg/L	0.0129	0.0129	0.0135	0.0135	0.0136	0.0135	0.02
SO4	mg/L	27.7	27.8	26.9	26.9	27.0	27.0	309
P	mg/L	0.215	0.215	0.230	0.230	0.229	0.229	0.1
WADCN	mg/L	0.000837	0.000837	0.00090	0.00090	0.00090	0.00090	0.005
D-Al	mg/L	0.163	0.163	0.0508	0.0508	0.0570	0.0584	0.05
Ag	mg/L	0.000039	0.000039	0.000041	0.000041	0.000041	0.000041	0.00025
As	mg/L	0.00232	0.00232	0.00246	0.00245	0.00246	0.00245	0.005
Ca	mg/L	31.9	31.9	31.7	31.7	31.7	31.7	-
Cd	mg/L	0.00048	0.00048	0.00052	0.00052	0.00052	0.00052	0.00014
Cr	mg/L	0.00263	0.00263	0.00278	0.00278	0.00277	0.00277	0.001
Cu	mg/L	0.00776	0.00776	0.00813	0.00813	0.00809	0.00809	0.0035
Fe	mg/L	3.01	3.01	3.21	3.21	3.20	3.20	1.0
Hg	mg/L	0.000009	0.000009	0.000007	0.000007	0.000007	0.000007	0.000026
Mg	mg/L	8.79	8.80	8.71	8.70	8.73	8.73	-
Mn	mg/L	0.169	0.169	0.180	0.180	0.180	0.179	0.966
Mo	mg/L	0.00139	0.00139	0.00139	0.00139	0.00155	0.00139	0.073
Ni	mg/L	0.00934	0.00934	0.00995	0.00995	0.00990	0.00990	0.086
Pb	mg/L	0.00226	0.00226	0.00241	0.00241	0.00240	0.00240	0.00266
Sb	mg/L	0.00155	0.00154	0.00186	0.00185	0.00185	0.00185	0.009

Parameter	Unit	YRdsCC4.5 Maximum monthly concentrations		YRdsYT24 Maximum monthly concentrations		YRdsHC5.0 Maximum monthly concentrations		Screening Level
		Base Case	Natural	Base Case	Natural	Base Case	Natural	WQG
Se	mg/L	0.00048	0.00048	0.00049	0.00049	0.00049	0.00049	0.002
Tl	mg/L	0.000030	0.000030	0.000032	0.000032	0.000033	0.000032	0.0008
U	mg/L	0.00188	0.00159	0.00133	0.00125	0.00250	0.00160	0.015
Zn	mg/L	0.0351	0.0351	0.0374	0.0374	0.0373	0.0373	0.0135

Notes:

Dark-shaded (Base Case) and light-shaded (Natural Case) cells represent concentrations that exceeds WQG
“Base Case" = model-predicted, mine-impacted water quality under expected or base case condition
"Natural Case" = model background case (no mine-impact); includes climate change effects
WQG = BC WQG or CCME WQG, based on guidelines identified in **Appendix 12-C-4** of this document
All metals shown as total fraction. Dissolved guideline for Al shown
Hardness- and pH-dependent guidelines calculated using 25th P of baseline dataset for corresponding station

In general, the water quality model predicts WQG exceedances in the Base Case for:

- Three parameters at Latte Creek stations CC-1.5 and CC-3.5 (D-Al, T-Cu, and T-U)
- Two parameters at Coffee Creek station CC-4.5 (D-Al and T-Cu,)
- Six parameters at Halfway Creek station HC-2.5 (NO3, D-Al, T-Cr, T-Cu, T-U and T-Zn) and four parameters at station HC-5.0 (D-Al, T-Cr, T-Cu, and T-U)
- Four parameters at Yukon Tributary station YT-24 (D-Al, T-As, T-Cu, and T-Zn), and
- Seven parameters (P, D-Al, T-Cd, T-Cr, T-Cu, T-Fe and T-Zn) at all Yukon River model nodes.

Guideline exceedances for certain parameters in the Base Case are largely driven by background concentrations (*e.g*., D-Al, T-Cr, T-Cu, T-U), which are naturally elevated in the Project area; this is reflected in the Natural Case (**Table 4.4-1; Table 4.4-2).**

Project-related increases to parameter concentrations that did not result in a WQG exceedance were not assigned residual effect characteristics or significance ratings. This approach was employed because CCME and BC WQGs are derived to be protective of sensitive organisms and life-stages for life-long exposure periods. Therefore, residual effects to surface water quality are not expected at concentrations predicted to occur below WQG concentrations. Some parameters, including CN, Hg, and Se, are identified as parameters of interest in other linked IC or VC assessments (e.g., fish and fish habitat; **Appendix 14-B**), but are not predicted to exceed guidelines at any time throughout the Project. Therefore, these parameters are not presented in the context of residual effects.

In the following sections, residual effects are evaluated by catchment for parameters predicted to exceed the corresponding CCME or BC WQG.

4.4.2.2 Latte Creek (stations CC-1.5 and CC-3.5)

In this section, residual effects predicted to occur at Latte Creek station CC-1.5 are described, followed by a description of significance and likelihood. Model results for station CC-3.5 are also presented for reference. While similar trends in Base Case water chemistry are predicted to occur at CC-3.5 as compared to CC-1.5, a higher relative proportion of mine-impacted water will report to CC-1.5 relative to CC-3.5. For these reasons, the assessment of residual effects to Latte Creek focuses on water quality predictions for CC-1.5.

Total U is the only parameter that was carried forward to the assessment of residual Project effects (below). Water quality guideline exceedances predicted for D-Al (**Figure 4.4-1, Figure 4.4-2**) and T-Cu (**Figure 4.4-3, Figure 4.4-4**) were driven exclusively by the Natural Case, and were therefore not carried forward to the assessment of mine-related effects. The Base Case model predicts slight increases to certain parameters above Natural Case at Latte Creek stations CC-1.5 and CC-3.5 (e.g., nitrate, nitrite, T-As, T-Mo, T-Sb, T-Tl, and T-Zn; **Table 4.4-2**), but the relative degree of change is low and predicted Base Case values remain below corresponding water quality guidelines. Residual Project effects are not anticipated at the predicted Base Case concentration levels for these parameters.

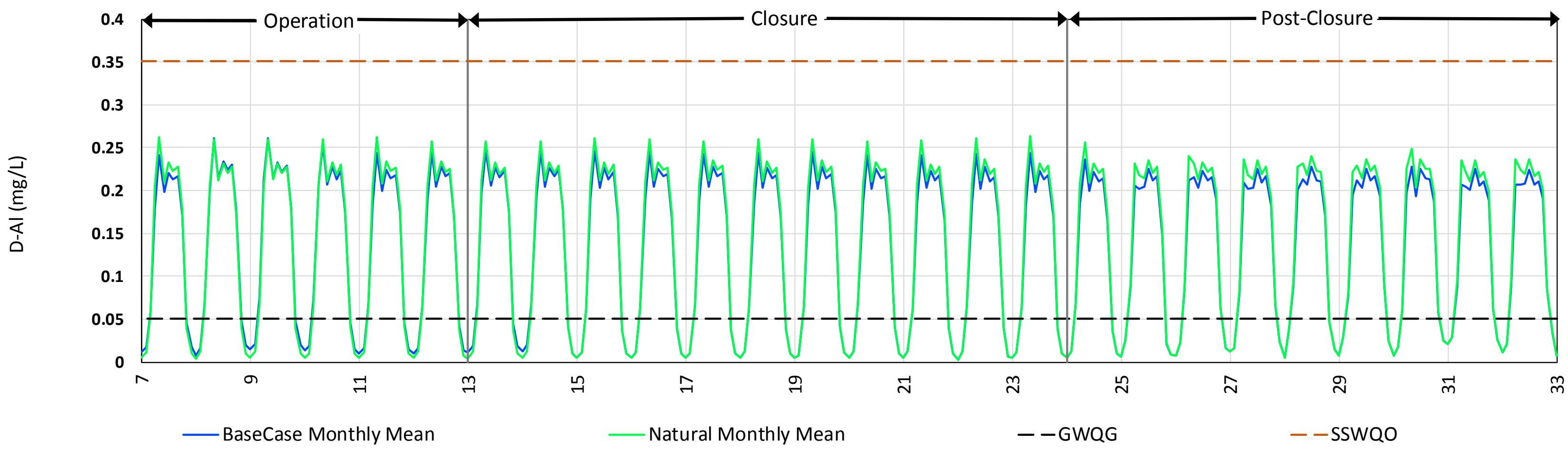

Figure 4.4-1 **Dissolved Aluminum Base Case compared to Natural case at CC-1.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective.**

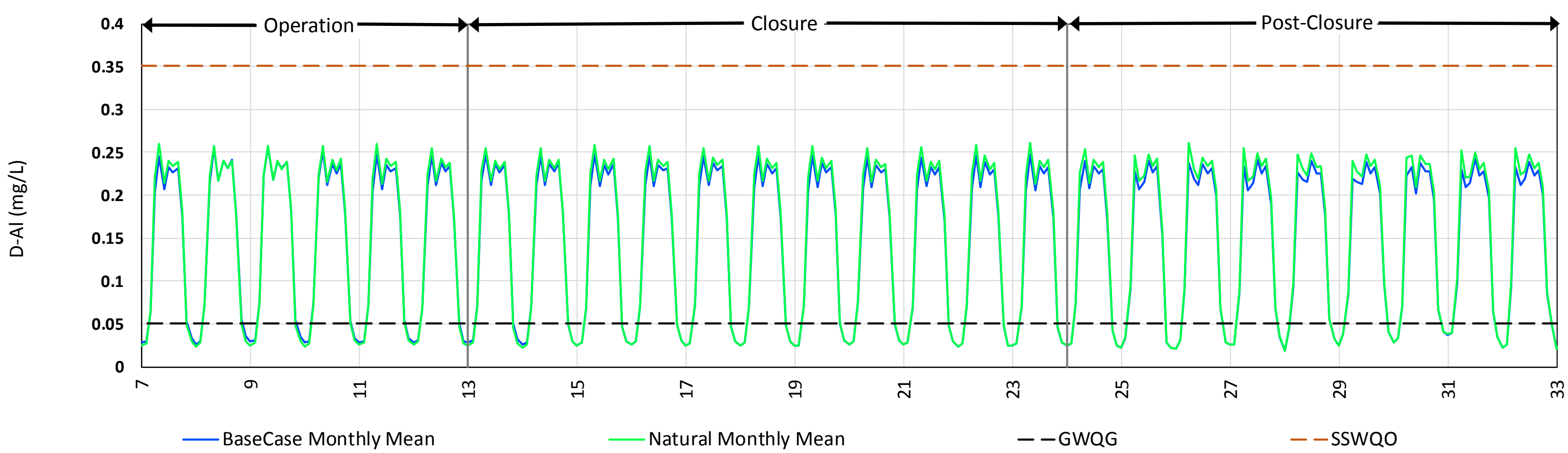

Figure 4.4-2 **Dissolved Aluminum Base Case compared to Natural case at CC-3.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective.**

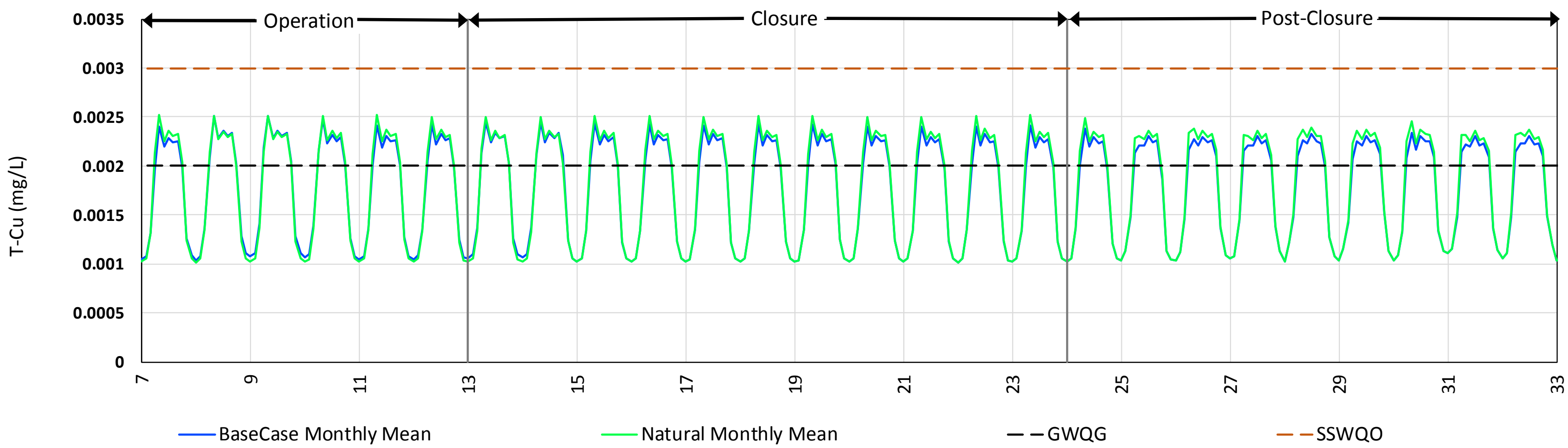

Figure 4.4-3 Total Copper Base Case compared to Natural case at CC-1.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective.

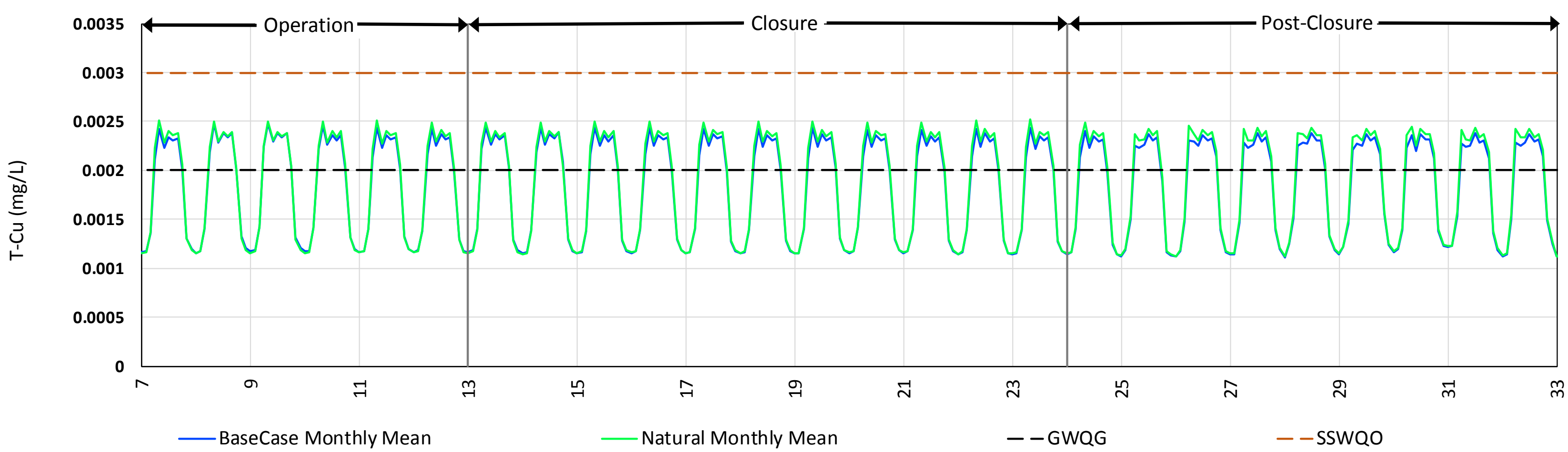

Figure 4.4-4 Total Copper Base Case compared to Natural case at CC-3.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective.

Total Uranium

Natural Case T-U concentrations regularly exceed the CCME long-term WQG in Latte Creek during winter months (November to March), most notably at CC-1.5 where values are commonly 1.5- to 3.0-times higher than CC-3.5, located further downstream. Because T-U concentrations in Latte Creek are naturally elevated above the CCME WQG, the PSSWQO for T-U was incorporated into the present assessment to screen Base Case model predictions.

Mine development is predicted to generally increase levels of T-U in Latte Creek. During the summer open-water period from Model Year 11 onwards, predicted Base Case concentrations are more than double Natural Case levels, but generally remain below the WQG. In contrast, mine development is expected to result in winter base-flow concentrations marginally (approximately 1 to 2 ug/L) higher than Natural Case, and up to 5% higher than the PSSWQO in model Years 11 to 14. For these reasons, T-U was carried forward as a residual effect.

The dominant source of U starting in the Operation phase is likely drainage associated with the Double Double Pit paired with background flows. Uranium is enriched in gneiss and schist waste rock (and ore) at the Project site (**Appendix 12-D** of the Project Proposal). As such, the predicted mine-related U loadings to Latte Creek will be controlled by the pH of mine site drainage and the presence of complexing ions which can promote U leaching from exposed rock surfaces.

Overall, Base Case modelling results for T-U at CC-1.5 are considered adverse in direction, as an increase in T-U levels from Natural Case has potential to cause toxicity to certain aquatic components (**Table 4.4-4**). Effects are considered moderate in magnitude, based on the predicted increase to mean monthly T-U concentrations above the PSSWQO during months of ice-over. Outside of this period, T-U levels are predicted to increase from Natural Case conditions but generally remain within the WQG and well below the proposed SSWQO.

The geographic extent of potential effects is considered local as Project-effects are expected to increase T-U throughout the Latte Creek catchment, but not Coffee Creek. The residual effect will likely occur regularly on an annual basis from the Operations phase onwards, through and beyond Post-Closure. As such, Project-related increase to T-U was considered continuous, permanent and irreversible.

The probability of occurrence is considered likely, given the present assessment considers the Base Case model scenario, which is considered a “best estimate” condition. A low context rating was assigned because Latte Creek is considered relatively resilient to the predicted increases in T-U, which is naturally elevated well above the CCME WQG in this system.

Table 4.4-4 Summary of Effect Characteristics Ratings for Total Uranium

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increase in T-U from baseline conditions has potential to cause toxic effects to aquatic receptors
Magnitude	Low	Mine-development has potential to increase T-U above the PSSWQO by a small margin (~5%) during winter low-flow. During the open-water period, Base Case values are roughly double the Natural Case, but occur equal to or below WQG
Geographic Extent	Local Assessment Area	Predicted increase from Natural Case occurs throughout Latte Creek drainage
Timing	Year-round	The Project is expected to increase T-U from Natural Case year-round to varying extent.
Frequency	Continuous	The effect occurs regularly on an annual basis
Duration	Permanent	Effect begins to occur in the latter half of Operations and persists beyond Post-Closure
Reversibility	Irreversible	Effect persists beyond the Post-Closure phase and is expected to remain changed from baseline conditions
Probability of Occurrence	Likely	The water quality model is based upon conservative assumptions and a robust baseline dataset.
Context	Low	Although no or limited development has occurred in the system, Latte Creek is naturally elevated in T-U and is considered to have low sensitivity.

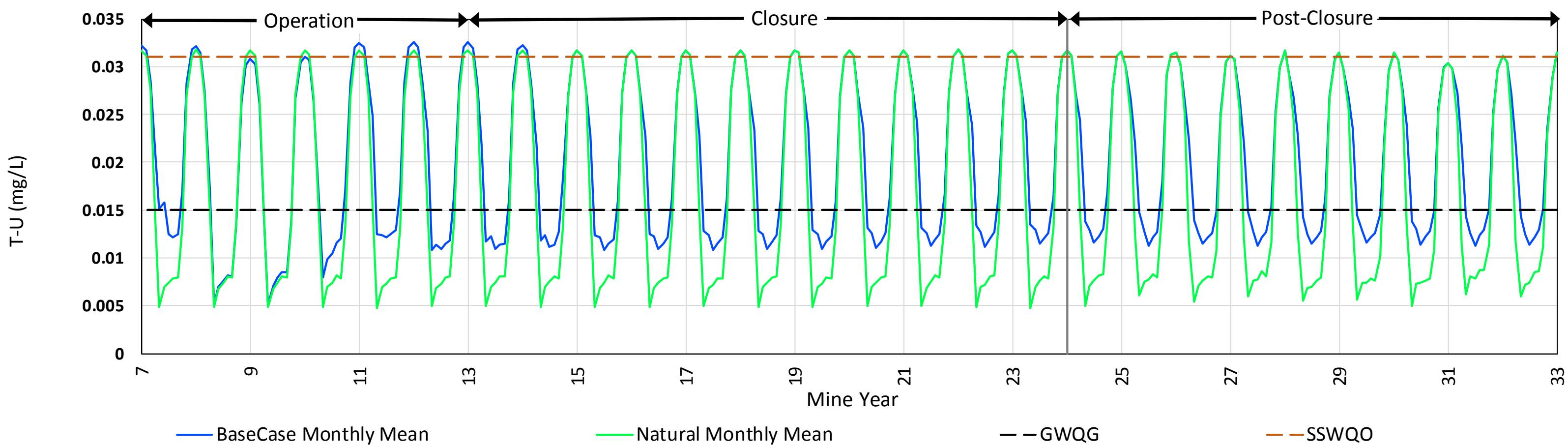

Figure 4.4-5 **Total Uranium Base Case compared to Natural case at CC-1.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective.**

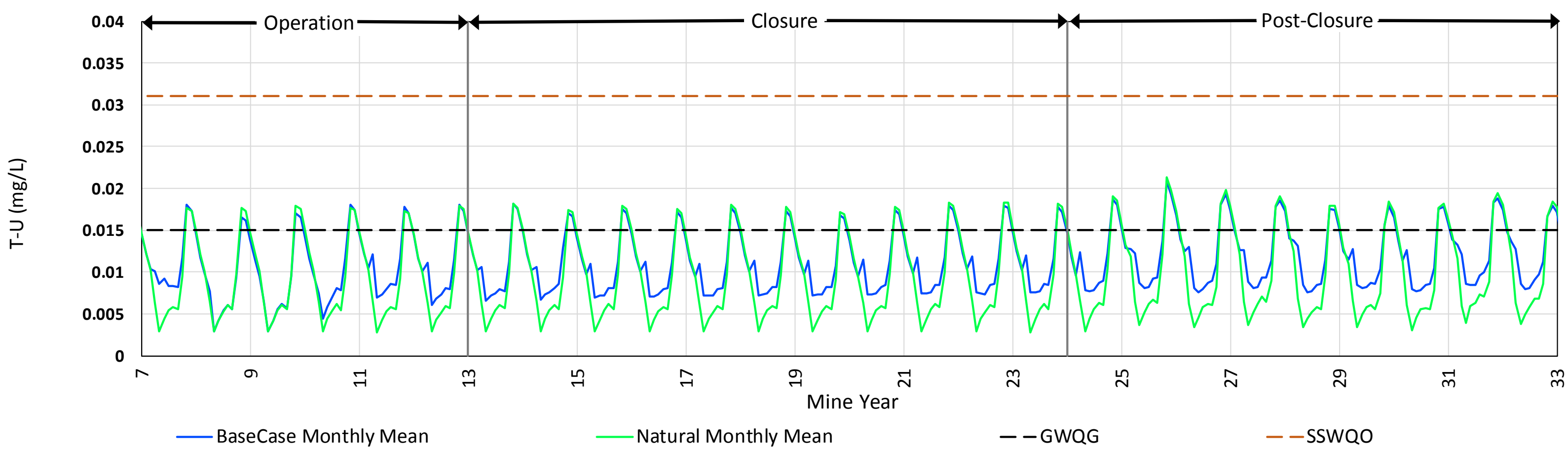

Figure 4.4-6 **Total Uranium Base Case compared to Natural case at CC-3.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective.**

Determination of Significance

Overall, mine-related contact water is predicted to result in residual effects to surface water quality in Latte Creek. Total uranium is the main parameter of concern. Mitigation measures have been incorporated into the project plan and the water quality model, which decrease the predicted effect measurably following application, although T-U levels remain elevated above corresponding WQG or the proposed SSWQO by a small margin for select months of the year, over a limited period of time during the project life.

Based on the effect characteristics described in the section above, potential residual effects from the Project to Latte Creek are considered not significant. This rating is assigned a high confidence level based on a high level of certainty in the water quality model predictions and the baseline water quality dataset. This assessment is further supported by the current understanding of U toxicity within the context of site conditions. In natural systems, the bioavailability of U is strongly influenced by its speciation (Markich, 2002). In oxic surface waters at circumneutral pH, such as those at the Coffee Creek project, U(VI) is predicted to be the dominant species. U(VI) can be present in a variety of forms including free uranyl ions (e.g., UO_2^{2+} and UO_2OH^+), inorganic complexes (U-carbonates) and organic complexes (e.g., U complexes with DOC). Available evidence in the primary literature suggests that UO_2^{2+} and UO_2OH^+ are the most bioavailable forms of U(VI) (Markich, 2002). U-carbonate complexes and U-organic complexes show decreased bioavailability. In particular, DOC (in the form of fulvic and humic acids) is a very effective complexing agent of U in freshwaters, and can greatly decrease U bioavailability and toxicity (Trenfield *et al*., 2011; Turner *et al*., 2012).

The seasonal changes in U concentration for Latte Creek will be accompanied by seasonal shifts in other parameters that have relevance to U bioavailability. Bicarbonate alkalinity (HCO_3^-), for example, shows congruent maxima with U during the winter period (i.e., groundwater source) (**Appendix 12-A**). In contrast, concentrations of dissolved organic carbon (DOC) are highest during the ice-free months owing to the enrichment of DOC in terrestrial runoff (**Section 3**). These seasonal cycles will have a corresponding effect on U speciation and bioavailability. Specifically, during the winter period, U can be expected to be dominated by U-carbonate complexes, while during the summer period, U-DOC complexes will become dominant. For both the winter and summer periods in project area streams at the Coffee Creek project, U bioavailability will be reduced by complexation with carbonate and DOC, respectively. Uranium complexation with DOC can be expected to result in a pronounced reduction in U bioavailability to aquatic taxa (Trenfield *et al*., 2011; Appendix B).

Site-specific chronic toxicity testing was performed in February 2016, using water collected from CC-1.5 and HC-2.5 (Appendix 12-C-4). The chronic toxicity tests conducted on these samples were performed using *Ceriodaphnia dubia*. Methods for the toxicity tests using *C. dubia* were conducted according to procedures described by Environment Canada (2007). Results of the toxicity testing indicated there were no adverse effects on survival or reproduction of *C. dubia* in either of the winter low flow site water samples tested despite U concentrations in excess of 75 µg/L (see Appendix 12-C-4 for full report). Winter low flow waters had correspondingly low DOC concentrations of approximately 4.0 mg/L in both Latte Creek and Halfway Creek.

Site waters at the Coffee Creek project show DOC levels during the ice-free months ranging from 10 to 20 mg/L between May and September (at CC-1.5 and HC-2.5). To evaluate the potential reduction in U toxicity from DOC, a second round of chronic toxicity testing using *C. dubia* was performed on site waters collected at HC-2.5 and CC-1.5 during June, 2016. However, for this test, individual chronic toxicity tests were performed on site waters spiked with increasing U concentrations (e.g. 0, 10, 20, 40, 80, 160 and 320 µg/L). There were no adverse effects to survival in any of the samples tested; the resulting LC values were therefore greater than the highest concentration tested (e.g. >351 µg/L for HC-2.5 spiked with 320 µg/L and naturally containing 21 µg/L U at the time of sample collection in June 2016). For the sample prepared with laboratory water, there were observed adverse effects on reproduction; the resulting IC25 and IC50 values were 106.2 and 141.6 µg/L U, respectively (see Appendix 12-C-4 for full report). Conversely, there were no adverse effects on reproduction in any samples CC1.5 or HC2.5 at all U concentrations.

Based on information available to date, no significant effects to Latte Creek are predicted.

4.4.2.3 Coffee Creek (CC-4.5)

No residual effects are predicted to occur at CC-4.5. Of the parameters considered in the water quality model, Base Case D-Al and T-Cu are predicted to exceed CCME or BC WQGs on an annual basis through all mine phases, but Base Case concentrations are equal to Natural Case. That is, exceedances are driven exclusively by naturally elevated background concentrations. For all other parameters, Base Case concentrations fell below their corresponding CCME or BC WQG, and were similar to Natural Case.

Because no differences are predicted between Base Case water quality and Natural Case, residual effect characteristics, significance determination and confidence ratings for CC-4.5 predictions were not determined. Predicted results for parameters exceeding the relevant WQGs are presented in this section for reference (**Figure 4.4-7**,and **Figure 4.4-8**; predicted water quality for CC-4.5 is presented in further detail in **Appendix 12-C** of the Project Proposal.

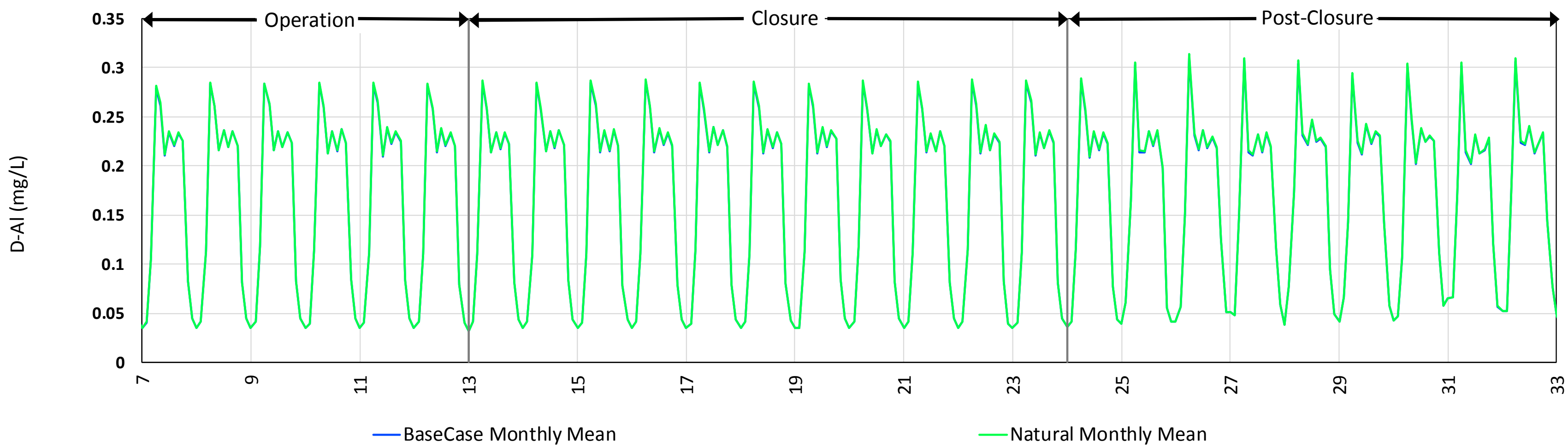

Figure 4.4-7 Dissolved Aluminum Base Case compared to Natural case at CC-4.5 through Operation, Closure, and Post-Closure Mine Phases.

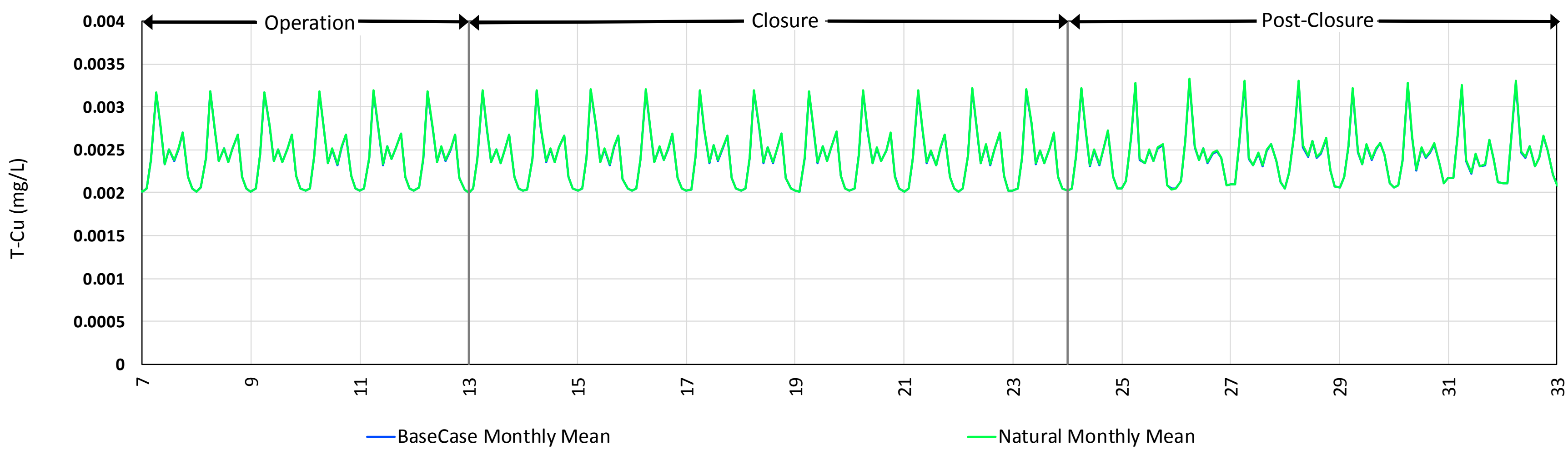

Figure 4.4-8 Total Copper Base Case compared to Natural case at CC-4.5 through Operation, Closure, and Post-Closure Mine Phases.

4.4.2.4 YT-24

Residual effects predicted to occur in YT-24 are described in this section by parameter, followed by a description of significance and likelihood.

Total As was carried forward to the assessment of residual Project effects to YT-24 (below). Water quality guideline exceedances predicted for D-Al and T-Cu were driven exclusively by the Natural Case (**Appendix 12-C**), and were therefore not carried forward to the assessment of mine-related effects. The Base Case model also predicts small increases to other parameters above Natural Case (**Table 4.4-2**) although the relative degree of change is low, and monthly maxima predictions remain below corresponding WQGs. Residual Project effects are therefore not anticipated at the predicted Base Case concentration levels for these parameters.

Total Arsenic

Total As at YT-24 is low in the Natural Case, consistently falling below 0.001 mg/L through the life of mine. In the Base Case, residual effects are anticipated from T-As, which is predicted to increase in YT-24 with Project development. The dominant source of As to YT-24 is expected to be run-off in contact with the exposed pit walls of the northern portions of the Supremo Pit (SU3W, SU3N (and SU4N), SU5N and SU5S). In contrast, As contributions from the North WRSF are minor.

Arsenic concentrations in the YT-24 Creek are predicted to deviate from the Natural Case starting in Construction, resulting in annual exceedances of the CCME long-term WQG (0.005 mg/L) in the months of May and October until model YR 10 (with one minor one-month exceedance in Year 14) (**Figure 4.4-9**). The rapid increase in As observed during the Construction phase is primarily due to the dissolution of As-bearing secondary oxide minerals and weathering of As-bearing sulphide minerals on the exposed pit walls. WQG exceedances during May and October are attributed to pit dewatering events during the open-water, as water accumulates in pits and is then discharged to the receiving environment, resulting in T-As peaks marginally above the guideline (i.e., up to 0.0063 mg/L, or 26% above the WQG). Outside of these months, Base Case T-As is predicted to remain below the WQG.

Based on this model output, the assessment of potential residual effects associated with T-As in YT-24 is focused on WQG exceedances occurring in the months of May and October during the Construction and Operational period. Following the Operational period, Base Case T-As falls to within Natural Case levels.

The predicted increase in T-As in the Base Case is considered adverse but low-magnitude as it represents a small relative exceedance of the CCME long-term WQG. The WQG for T-As is based on the sensitivity to a species of planktonic algae (*Scenedesmus obliquus*) in chronic toxicity tests, which show reduced growth at a D-As concentration of 0.050 mg/L (CCME 1999). A conservative safety factor of 0.1 was applied to this lowest observable effect level to obtain the 0.005 mg/L aquatic life guideline. For this reason, the long-term WQG is considered a conservative screening threshold for Base Case predictions.

The geographic extent of the predicted effect is limited to the Local Assessment Area (the YT-24 catchment) occurring during open-water months (May and October) as a multiple-regular event. The effect is considered to occur over a long-term duration, and is reversible. The probability of occurrence is considered likely, given water quality model assumptions are considered conservative and reflect the expected case.

A low context rating is assigned, as YT-24 is an ephemeral stream with low relative ecological value. In general, primary producers, and most notably chlorophytes, are likely amongst the most sensitive receptors to elevated arsenic (CCME 1999); however, baseline studies for the Project area, including YT-24, show periphyton communitiesare dominated by blue-green algae (Cyanophyta; approximately 80%), followed by diatoms, and subsequently a small percentage of green algae (Chlorophyta) (**Appendix 14-A**).

Table 4.4-5 Summary of Effect Characteristics Ratings for Total Arsenic

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increase in T-As from baseline conditions is not expected to benefit aquatic biota or aquatic habitat
Magnitude	Low	The effect represents a small relative exceedance of the long-term WQG.
Geographic Extent	Local Assessment Area	The predicted increase from Natural Case occurs throughout YT-24 drainage
Timing	Open-water period	Effect occurs in the months of May and October
Frequency	Multiple regular event	The effect occurs periodically during the Construction and Operational phases
Duration	Long-term	The effect occurs over more than one year through the Construction and Operational phases, but ceases following the Operational period
Reversibility	Reversible	The T-As concentration falls below the WQG once the effect ceases, but does not return to baseline levels
Probability of Occurrence	Likely	The water quality model is based upon conservative assumptions for the Expected Case.
Context	Low	The system is considered resilient to the predicted change (i.e., low sensitivity)

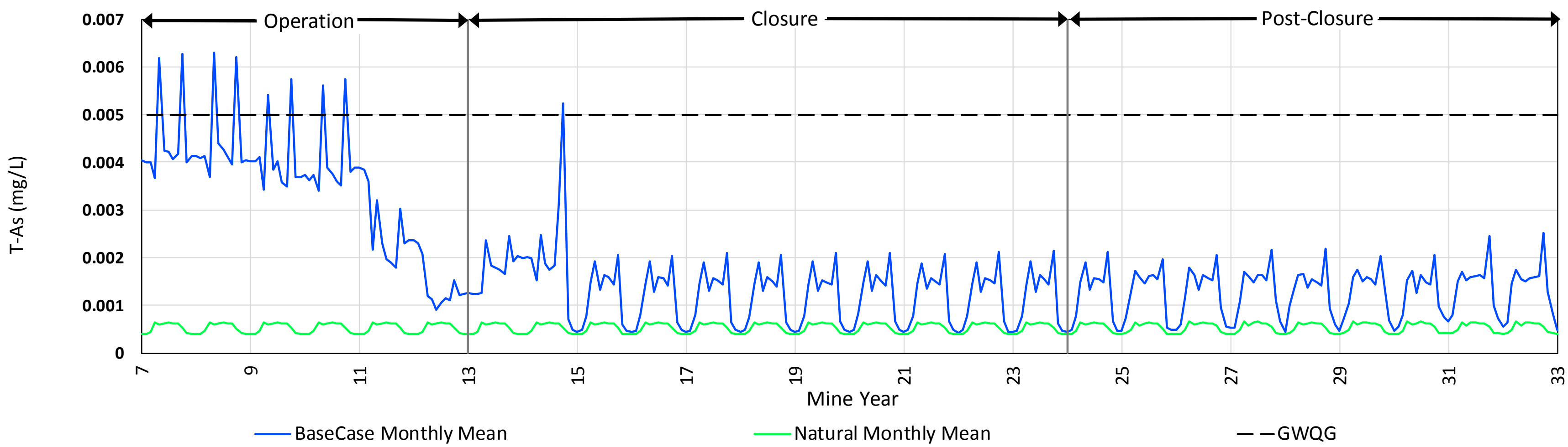

Figure 4.4-9 **Total Arsenic Base Case compared to Natural case at YT-24 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life.**

Determination of Significance

Overall, mine-related contact water is predicted to result in residual effects to surface water quality in YT-24. Total arsenic is the main parameter of concern. Mitigation measures have been incorporated into the project plan and the water quality model, which decrease the predicted effect measurably, although T-As levels remain elevated above its corresponding WQG by a small margin for select months of the year, over a limited period of time during the project life.

Base Case residual effects from T-As are therefore rated not significant based on the effect characteristics described above. This rating is assigned a high confidence level, given the relative level of certainty in the water quality model predictions and the level of understanding of the Project receiving environment. As discussed, the CCME long-term WQG for T-As is considered conservative, and was derived by applying a 0.1 uncertainty factor to the most sensitive long-term toxicity endpoint in the appropriate literature for aquatic biota (0.050 mg/L lowest observed effect level endpoint for *S. obliquus*). Peak mean monthly T-As concentrations predicted in the Base Case for YT-24 represent a small exceedance of this WQG, occurring on a sporadic basis. Aquatic receptors in YT-24 are not expected to incur toxic effects at the T-As levels predicted. For these reasons, residual project effects to surface water quality in YT-24 are characterized as not significant for the modelled Base Case scenario.

4.4.2.5 Halfway Creek

Residual effects predicted to occur at Halfway Creek station HC-2.5 are described in this section by parameter, followed by a description of significance and likelihood. Model results for station HC-5.0 are also presented for reference. While similar trends in Base Case water chemistry are predicted to occur at HC-5.0 as compared to HC-2.5, a higher relative proportion of mine-impacted water will report to HC-2.5 relative to HC-5.0. For these reasons, the assessment of residual effects to Halfway Creek focuses on water quality predictions for HC-2.5.

Nitrate, T-U, and T-Zn were carried forward to the assessment of residual Project effects to Halfway Creek (below). The Base Case model also predicts small increases to other parameters above Natural Case (**Table 4.4-3**) although the relative degree of change is low, such that residual Project effects associated with these parameters are not anticipated.

Nitrate

The bulk of mine site area nitrate loading is expected to originate from nitrogen-based explosives use. Natural Case concentrations of all nitrogen species (ammonia, nitrite, nitrate) at HC-2.5 occur near the analytical method detection limit **(Figure 4.4-10**; **Figure 4.4-11)**. In the Base Case, nitrate peaks annually up to 2.3 mg-N/L during May and June in Halfway Creek beginning in Construction in association with mine development (i.e., surface blasting), and continuing through the Operational period. In model YR 20, annual peaks increase up to 4.3 mg-N/L during the months of May to July, returning to Natural Case levels during the ice-cover season. These levels are expected to gradually return to Natural Case levels following the cessation of mine development.

Residual effects from nitrate are predicted in association with annual WQG exceedances during the open-water period (typically May to July) starting in model YR 20 (**Figure 4.4-10**; **Figure 4.4-11**). Nitrogen residues, including nitrate, in the Project area will gradually decline as nitrogen residues deplete Base Case nitrate is not predicted to exceed its corresponding BC short-term WQG (32.8 mg-N/L) at any point in mine life.

Overall, the predicted Base Case nitrate concentrations in Halfway Creek are considered adverse in direction (**Table 4.4-6**). Although small increases in nitrate concentration, as a nutrient, has potential to benefit aquatic communities (increasing growth and productivity), concentrations greater than the BC WQG may adversely change stream productivity (including effects to benthic algae and invertebrate communities) or contribute to chronic toxicity in sensitive receptors.

The predicted Project-effect to HC-2.5 is considered low in magnitude, given peak Base Case nitrate levels predicted to occur (4.3 mg-N/L) exceed the BC long-term WQG by a small relative margin (44%).

The geographic extent of the predicted effect is limited to the LAA as it will occur throughout the Halfway Creek drainage. With respect to timing and frequency, Base Case exceedances of the BC WQG occur during the open-water period as a multiple-regular event until mine development ceases. Given Project-related nitrogen sources will be finite, nitrate in YT-24 will eventually return to baseline. The predicted effect is therefore considered long-term, but fully reversible.

The probability of occurrence of the predicted residual effects is likely, given Base Case water quality model assumptions reflect the expected case scenario, and modelling source terms rely upon empirical data from analogue mine sites.

Finally, residual effects from elevated nitrate in Halfway Creek are considered to have moderate context. Baseline monitoring of Halfway Creek (Section 3) suggests the system is oligotrophic and may respond to increased nitrate levels with increased primary producer growth. However, the magnitude of this growth with be largely, limited by the availability of dissolved P, which is predicted to be low (Appendix 12-C). With respect to potential toxic effects, given the high level of conservatism integrated into the BC long-term WQG, potential toxic effects at the nitrate levels predicted are not expected.

Table 4.4-6 Summary of Effect Characteristics Ratings for Nitrite and Nitrate

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increase in nitrate and nitrite from baseline conditions has potential to cause toxic effects to aquatic biota and/or change stream productivity
Magnitude	Low	Predicted Base Case represents a small relative increase from Natural Case
Geographic Extent	Local	Predicted increase from Natural Case occurs throughout Halfway drainage
Timing	Open-water period	Effect typically occurs from May to July
Frequency	Multiple regular events	Occurs annually through and beyond the Closure phase
Duration	Long-term	Effect occurs through Closure before subsiding in Post-Closure, Closure, and in part of the Post-Closure phase.
Reversibility	Fully reversible	Effect may persist beyond the Closure phase, but will eventually return to baseline conditions
Probability of Occurrence	Likely	The water quality model is based upon conservative assumptions for the expected case
Context	Moderate	The system is considered moderately sensitive to predicted nitrate and concentrations and fairly resilient.

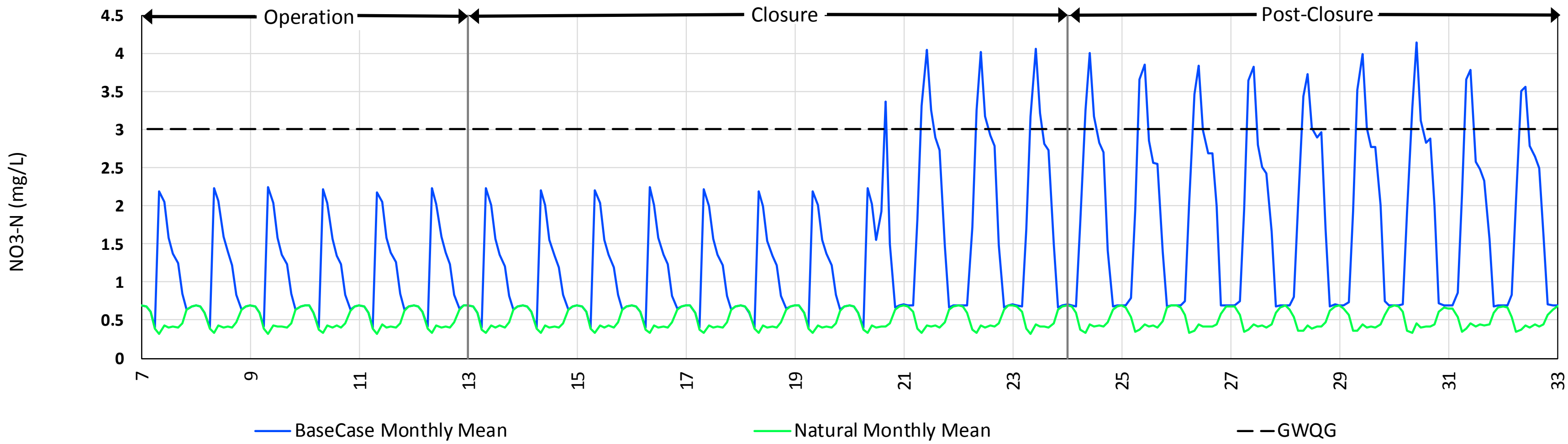

Figure 4.4-10 Nitrate Base Case compared to Natural case at HC-2.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic BC long-term water quality guideline for the protection of freshwater aquatic life.

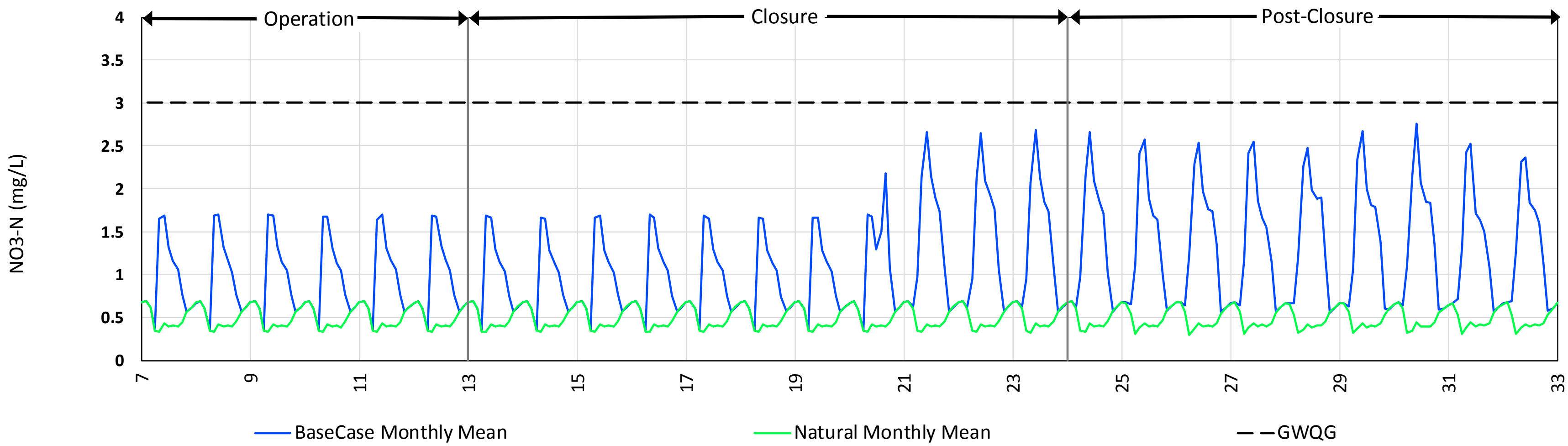

Figure 4.4-11 Nitrate Base Case compared to Natural case at HC-5.0 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life.

Total Uranium

Natural Case T-U at HC-2.5 exceeds the CCME long-term WQG on an annual basis in almost all months of the year, except spring/summer freshet when ambient T-U levels are diluted by background (low T-U) surface meltwater (**Figure 4.4-12**). By comparison, seasonal concentrations at HC-5.0 are comparatively lower and the seasonal signature more closely follows the surface flow regime (annual maxima during spring/summer freshet, minima during winter low flow).

Mine development is predicted to increase levels of T-U in Halfway Creek and is expected to result in a residual effect. Although there are several sources of U from the Project to Halfway Creek, loading associated with the Alpha WRSF represents the dominant source of T-U throughout the span of the Project.

The most notable residual effect at HC-2.5 in the Base Case is a persistent increase to T-U concentrations above the CCME WQG during months of open water starting in the Construction phase, continuing through Closure and beyond Post-Closure. This effect is driven by discharge from the Alpha WRSF (**Figure 4.4-12**). In contrast, HC-2.5 Base Case concentrations during the winter low flow period sync with the Natural Case in all phases owing to the naturally-high background signature.

Based on these results, residual effects for Base Case T-U are evaluated at HC-2.5 for the open-water period. This approach was used as the predicted values for this case reflect the station and period when the relative Project-effects are likely greatest.

Overall, Base Case modelling results for T-U at HC-2.5 during the open-water period are considered adverse in direction as elevated T-U concentrations have potential to cause toxic effects to certain aquatic biota (**Table 4.4-7**). Effects are considered moderate in magnitude, given the Base Case predictions considered here (i.e., for months of open water—April to September) exceed corresponding Natural Case predictions (and the WQG) by approximately 3-times, but remain below the PSSWQO throughout mine life.

The geographic extent of potential effects is considered to be within the LAA, as Project-effects are expected to increase T-U throughout Halfway Creek. The residual effect will likely occur regularly on an annual basis from the Construction phase onwards, through and beyond Post-Closure making the residual effect multiple regular event, long-term, and irreversible. The probability of occurrence is considered likely, given water quality model assumptions are considered conservative, reflect the expected case, and rely upon a robust baseline dataset.

Halfway Creek is considered resilient to the predicted increase in T-U but has limited or no pre-existing development within the catchment, resulting in a low context rating. Background T-U levels at HC-2.5 naturally occur well above the CCME long-term WQG in most months of the year, with peak annual values coinciding with winter low flow. Aquatic receptors inhabiting Halfway Creek are likely resilient to elevated T-U; all Base Case predictions remain well below the PSSWQO.

Table 4.4-7 Summary of Effect Characteristics Ratings for Total Uranium

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increase in T-U from baseline conditions has potential to cause toxic effects to aquatic receptors
Magnitude	Moderate	The effect results in long-term exceedance of the CCME WQG (up to ~3-times), but not the PSSWQO. Potential effects will be partly mitigated by coincident increase in background DOC
Geographic Extent	Local Assessment Area	Predicted increase from Natural Case occurs throughout Halfway Creek drainage
Timing	Open-water	Potential residual effects are likely to occur during the open-water period
Frequency	Multiple regular event	The effect occurs regularly during the open water period on an annual basis
Duration	Long-term	Effect begins to occur in Construction and persists beyond Post-Closure
Reversibility	Irreversible	Effect persists beyond the Post-Closure phase and is expected to remain changed from baseline conditions
Probability of Occurrence	Likely	The water quality model is based upon conservative assumptions and reflects the expected case.
Context	Low	The system is considered resilient to the predicted change

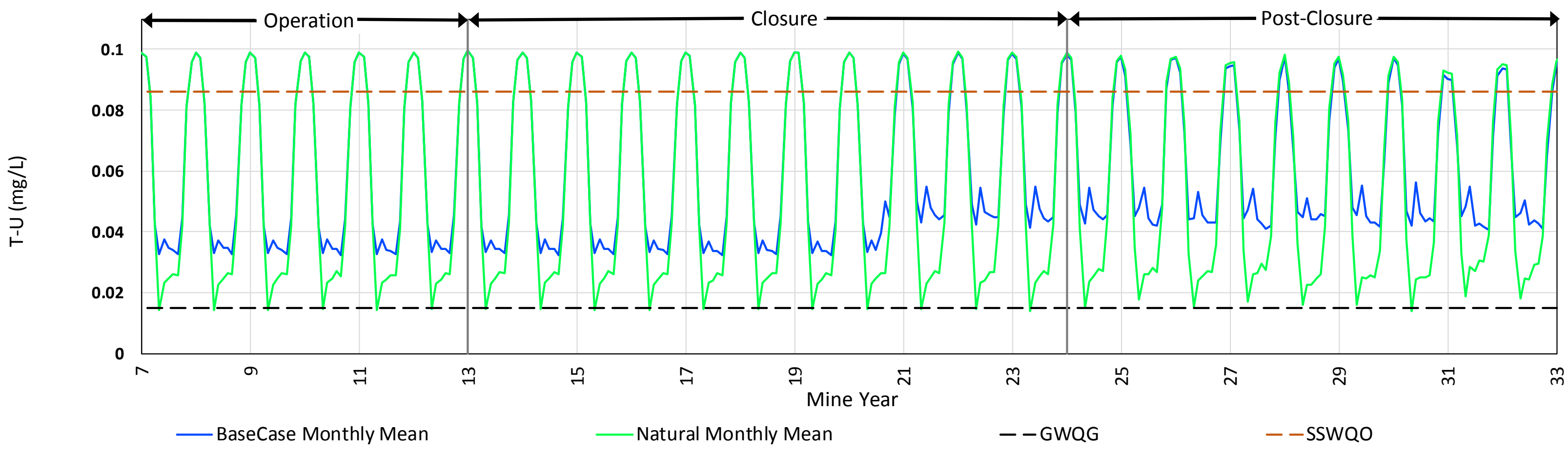

Figure 4.4-12 Total Uranium Base Case compared to Natural case at HC-2.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective for HC-2.5.

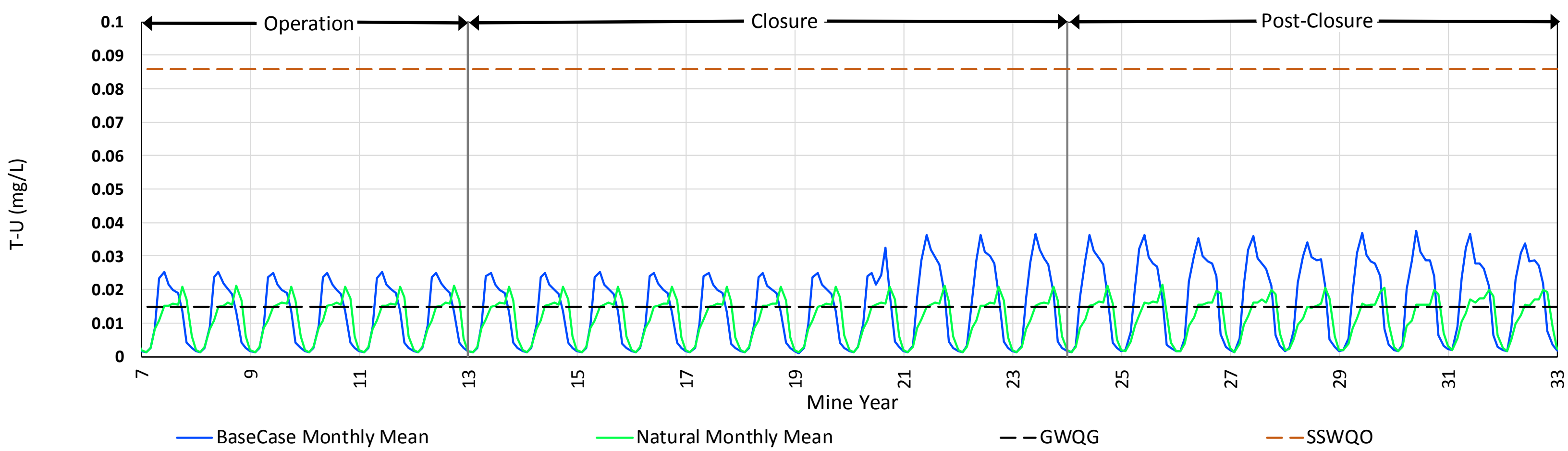

Figure 4.4-13 Total Uranium Base Case compared to Natural case at HC-5.0 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life. SSWQO = preliminary site-specific water quality objective for HC-2.5.

Total Zinc

Natural Case T-Zn levels in Halfway Creek are low year-round (mean monthly maximum for all mine phases <0.005 mg/L), consistently falling below the (draft) CCME long-term WQG. In the Base Case, T-Zn increases from Natural Case through Construction and the first half of Operations (**Figure 4.4-14**), but remains below the WQG. In model YR 20, T-Zn levels are predicted to exceed the WQG for one month (up to 0.0156 mg/L, representing a 20% exceedance of the WQG) in response to a low-flow period in the model coinciding with the shut-down of the HLF treatment facility (resulting in contact water from the HLF draindown discharging to Latte Pit, and ultimately Halfway Creek). Following this event, Base Case T-Zn continues to peak annually during the open-water period, with peaks reaching values up to or marginally above the WQG through and beyond Post-Closure (**Figure 4.4-14**). Gneiss rock at the Project is not considered to be enriched in Zn; however, field tests have demonstrated that increased dissolved constituents are expected in drainage from stockpiled gneiss transition and fresh facies waste rock (**Appendix 12-D**).

Residual effects associated with Base Case predictions for T-Zn are considered adverse in direction, as elevated metal concentrations have potential to cause toxic effects in certain organisms (**Table 4.4-8**), and low in magnitude given the small relative WQG exceedance predicted. The geographic extent of potential effects is considered local as T-Zn is expected to increase throughout the Halfway Creek catchment, while the Project-effect is most likely to coincide with the open-water period. The residual effect is characterized as a single event, over the short-term and reversible. The probability of occurrence is considered likely, given conservative assumptions employed throughout the water quality model and represents that expected case.

The context for residual effects is considered low, given the event is a single occurrence and limited to one month. Potential sensitive receptors of T-Zn toxicity, like fish, are likely limited to the lowest reach of Halfway Creek at which T-Zn levels are predicted to remain well below the WQG. Potential effects associated with T-Zn are expected to be further mitigated with increased hardness predicted to occur in the Halfway Creek drainage, which the WQG screening threshold does not take into account.

Table 4.4-8 Summary of Effect Characteristics Ratings for Total Zinc

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Increase in T-Zn from baseline conditions has potential to cause toxic effects to aquatic biota
Magnitude	Low	Predicted Base Case represents a small relative increase from Natural Case and a small (~20%) exceedance of the WQG
Geographic Extent	Local Assessment Area	Predicted increase from Natural Case occurs throughout Halfway Creek drainage
Timing	Open-water period	Effect occurs in month of September
Frequency	Single event	Occurs in one month of the modelled timeframe
Duration	Short-term	Effect is limited to one month
Reversibility	Reversible	Effect returns below the WQG immediately after it occurs
Probability of Occurrence	Likely	The water quality model is based upon conservative assumptions and reflects the expected case
Context	High	The system is considered to have high resilience to the predicted change

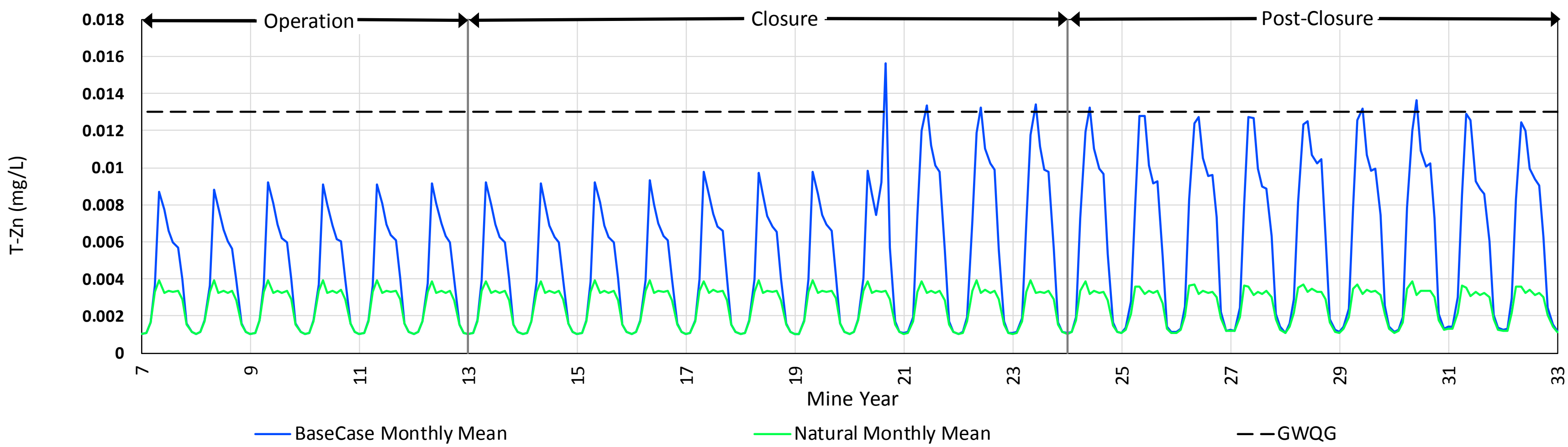

Figure 4.4-14 Total Zinc Base Case compared to Natural case at HC-2.5 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life.

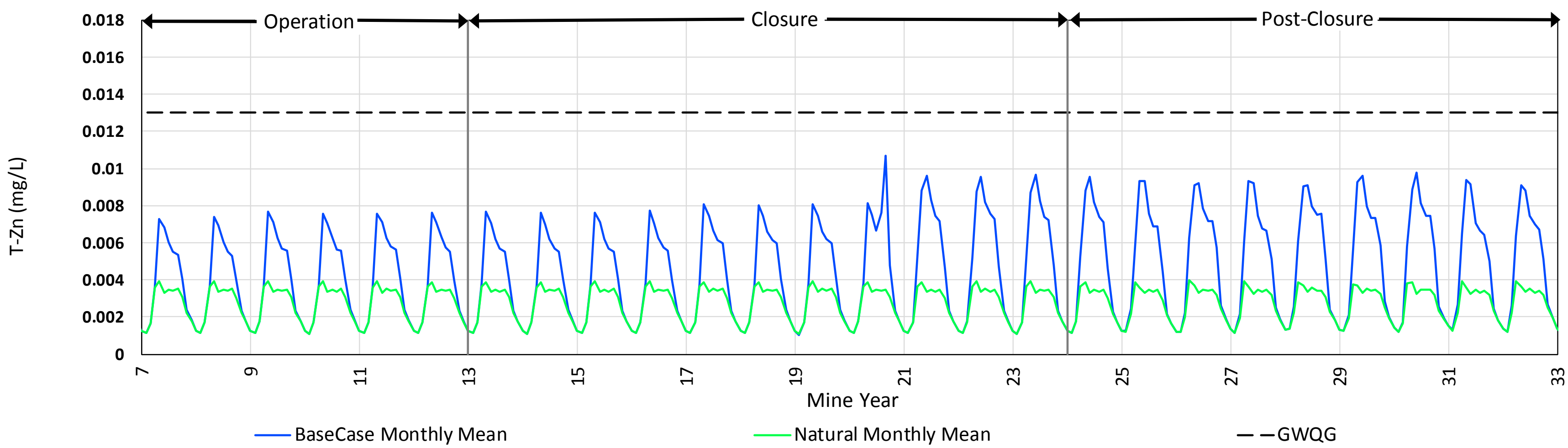

Figure 4.4-15 Total Zinc Base Case compared to Natural case at HC-5.0 through Operation, Closure, and Post-Closure Mine Phases. GWQG = generic CCME long-term water quality guideline for the protection of freshwater aquatic life.

Determination of Significance

Overall, mine-related contact water is predicted to result in residual effects to surface water quality in Halfway Creek. Nitrate, T-U, and T-Zn are the main parameters of concern. Mitigation measures have been incorporated into the project plan and the water quality model, decreasing the predicted effect measurably although Base Case predictions for these parameters remain elevated above their corresponding WQGs by a small margin for select months of the year, over a limited period of time during the project life.

Residual effects to Halfway Creek associated with nitrate, T-U and T-Zn are rated as not-significant based on the effect characteristics described above. This rating is assigned a moderate confidence level. Although there is a high level of certainty in the water quality model predictions, there is uncertainty associated with parameter-specific factors relevant to this assessment, each of which are discussed below.

With respect to nitrate, uncertainty exists in both the model assumptions (i.e., the effectiveness of management plans and long-term leaching rates following the cessation of blasting) and the current level of understanding of the receiving environment (i.e., mitigating factors like nitrogen attenuation and uptake). Within the context of the water quality model, model assumptions for nitrogen terms may be subject to higher uncertainty than geochemical source terms. This is because the effectiveness of nitrogen management plans implemented during Construction and Operations phases will largely determine the amount of nitrogen loss from blasting residues to Project sources (in contrast with geochemical sources, for which leaching rates may be directly related to volume or tonnage of rock disturbed refer to **Appendix 12-D** of the Project Proposal for further detail). Project-related nitrogen loads are finite and will eventually exhaust, causing nitrate concentrations to eventually return to baseline levels. The timeline around this process, however, is uncertain and depends on several Project-related and environmental variables, including attenuation and update of nitrogen species within sub-surface flow paths.

For T-U, this assessment is further supported by the current understanding of U toxicity within the context of the Coffee Project area, in which several catchments (e.g., Halfway Creek, Latte Creek) shown naturally elevated T-U in local baseflow. As described for Latte Creek (above), potential U-related toxicity in Halfway Creek is expected to be low due to both the U species and toxicity-mitigating factors (DOC) occurring in Halfway Creek water quality. In further support of this assessment, site-specific chronic toxicity testing performed using HC-2.5 water in February 2016 and June, 2016, using *C. dubia* showed no adverse effects on survival in water containing up to 75 µg/L and 320 ug/L, respectively (refer to Section 4.4.2.2 for further detail),

For T-Zn, there may be uncertainty associated with the WQG used to screen Base Case predictions for residual effects (the draft CCME WQG). Because this guideline has been issued in draft form it may be subject to change prior to its final approval. It is noted, however, that use of the current CCME WQG for

T-Zn (0.030 mg/L; CCREM 1987) in the present assessment would result in a less-conservative approach. Indeed, all monthly mean T-Zn values predicted in the Base Case for life of mine fall below the current CCME WQG for T-Zn, and would yield the conclusion of no residual effects in YT-24. As such, the current approach is considered conservative for the purpose of screening T-Zn predictions.

Based on information available to date, no significant effects to Halfway Creek are predicted.

4.4.2.6 Yukon River

No residual effects are expected at the three model nodes in the Yukon River downstream of Project inputs (YRdsCC4.5, YRdsYT24, and YRdsHC5.0) during any Project phase. In the Natural Case, P, D-Al, Cd, Cr, Cu, Fe and Zn, exceed guidelines during spring freshet on an annual basis. This trend is mirrored in the Base Case, and the Project is not predicted to measurably increase mean monthly concentrations shown in Base Case above the Natural Case. Representative plots for Yukon River model nodes for T-U are shown for reference (**Figure 4.4-16**, YRdsCC4.5; **Figure 4.4-17**, YRdsYT24; **Figure 4.4-18**, YRdsHC5.0).

The absence of a measurable Project effect is attributed to the large Yukon River catchment size (approximately 147,340 km^2) compared to Project area streams (e.g., Halfway Creek drainage area is approximately 30 km^2), affording significant dilution of Project-related loading.

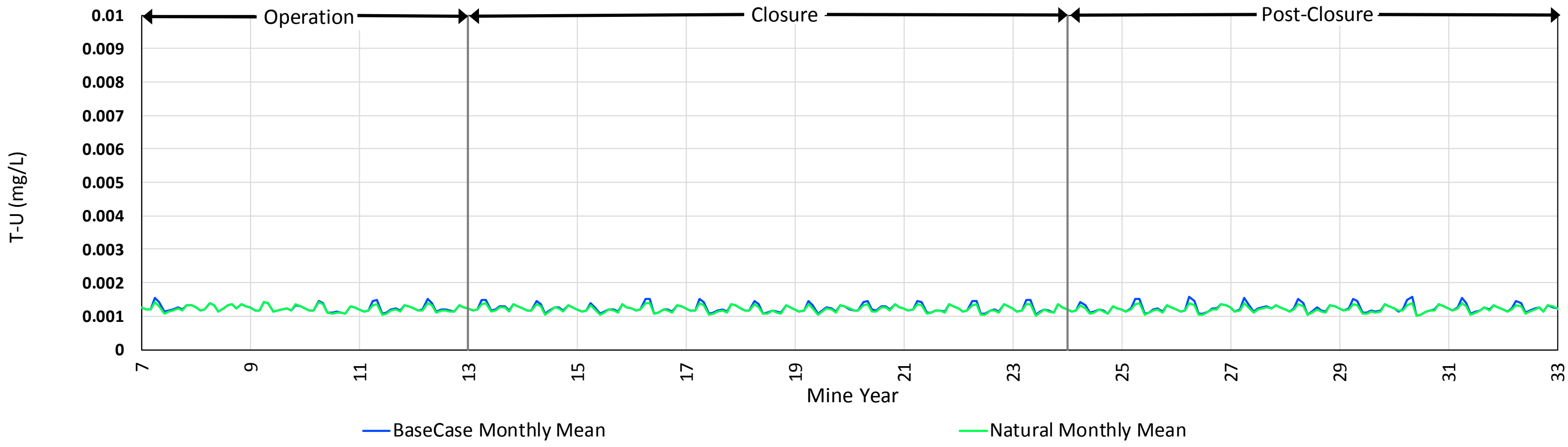

Figure 4.4-16 Total Uranium Base Case at YRdsCC4.5 through Construction, Operation, Active Closure, and Post-Closure Mine Phases.

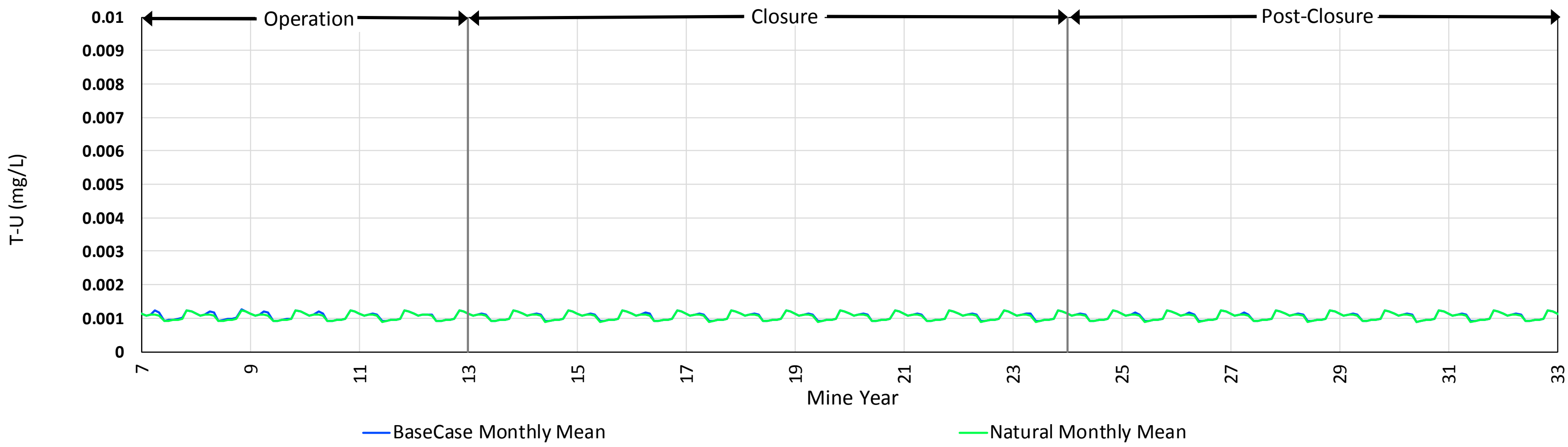

Figure 4.4-17 Total Uranium Base Case at YRdsYT24 through Construction, Operation, Active Closure, and Post-Closure Mine Phases.

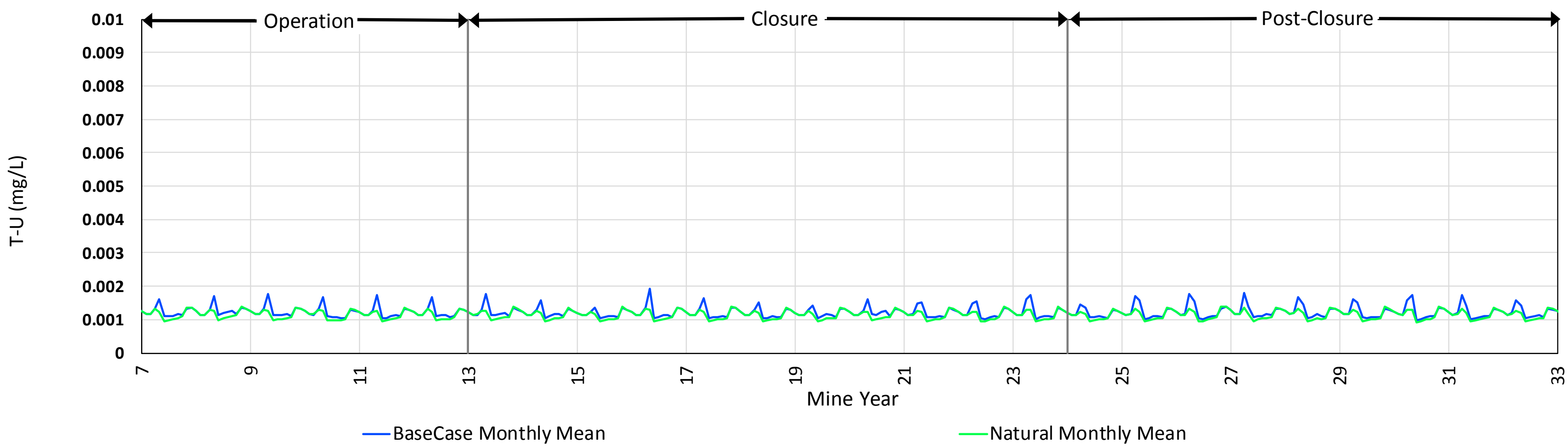

Figure 4.4-18 Total Uranium Base Case at YRdsHC5.0 through Construction, Operation, Active Closure, and Post-Closure Mine Phases.

4.4.3 SUMMARY OF PROJECT–RELATED RESIDUAL ADVERSE EFFECTS AND SIGNIFICANCE

In this section, the Project-related residual adverse effects and their significance for the Base Case model condition are summarized.

Overall, residual Project effects in the Base Case are anticipated in:

- Latte Creek with T-U as the main parameter of concern (**Table 4.4-4**)
- YT-24 with T-As as the main parameter of concern, and
- Halfway Creek with nitrate (). T-U (**Table 4.4-7**), and T-Zn as the main parameters of concern.

No residual effects are predicted to occur in Coffee Creek, or the Yukon River downstream of Coffee Creek, YT-24 or Halfway Creek confluences.

Of the residual effects identified in the Project area, all are characterized as Non-Significant. In **Table 4.4-9**, **Table 4.4-10** and **Table 4.4-11**, residual effects are summarized by catchment, alongside contributing Project activities and proposed mitigations, followed by the corresponding residual effects assessment characteristics.

Confidence ratings for residual effects assessments described in **Section 4.4.2** vary in part due to the level of certainty in modelling assumptions and environmental variability. For this reason, additional model scenarios (sensitivities) were run in order to characterize the relative sensitivity of environmental variability (represented by geochemical and climate inputs) on water quality predictions. These model sensitivities and results are described further in **Appendix 12-C** of the Project Proposal.

Table 4.4-9 Summary of Potential Residual Adverse Effects for Surface Water Quality in Latte Creek

Potential Residual Adverse Effects	Contributing Project Activities	Proposed Mitigation Measures	Residual Effects Characterization (see Notes for details)										
			Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Probability of Occurence	Context	Significance	Level of Confidence
Construction Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-U)	Pit development and dewatering Development and use of WRSFs Development and use of HLF and treatment facility	Phased mine development and progressive reclamation Waste rock management Management of potential ARD Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	YR	LT	CF	I	L	L	NS	HCo
Operation Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-U)	Pit development and dewatering Development and use of WRSFs Development and use of HLF and treatment facility	Phased mine development and progressive reclamation Waste rock management Management of potential ARD Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	YR	LT	CF	I	L	L	NS	HCo
Closure and Reclamation Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-U)	Ongoing discharges from closed and backfilled pits, reclaimed WRSFs Dismantling of stockpiles and other mine site facilities Reclamation and closure of HLF, including operation of HLF treatment facility	Phased mine development and progressive reclamation Waste rock management Management of potential ARD Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	YR	LT	CF	I	L	L	NS	HCo

Potential Residual Adverse Effects	Contributing Project Activities	Proposed Mitigation Measures	Residual Effects Characterization (see Notes for details)										
			Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Probability of Occurence	Context	Significance	Level of Confidence
Post-closure Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO(T-U)	Site closed – ongoing effects from activities in prior phases	Monitoring and adaptive management	A	LM	LAA	YR	LT	CF	I	L	L	NS	HCo

Notes:

Direction	P = Positive, A= Adverse
Magnitude:	LM = Low magnitude, MM = Moderate magnitude, HM = High magnitude
Geographic Extent:	PA = Project area, LAA = Local Assessment Area, RAA = Regional Assessment Area
Timing:	OW = Open-water period, IC = Ice-cover period, YR = Year-round
Duration:	ST = Short-term, MT = Medium-term, LT = Long-term
Frequency:	SI = Single event; MIE = Multiple irregular event; MRE = multiple regular event; CF = Continuous
Reversibility:	R = Fully reversible, I = Irreversible
Probability of Occurrence:	L = Likely, U = Unlikely
Context:	L=Low, M=Moderate, H=High
Significance:	NS = Not-Significant, S = Significant
Level of Confidence:	LCo = Low confidence, MCo = Moderate confidence, HCo = High confidence

Table 4.4-10 Summary of Potential Residual Adverse Effects for Surface Water Quality in YT-24

Potential Residual Adverse Effects	Contributing Project Activities	Proposed Mitigation Measures	Residual Effects Characterization (see Notes for details)										
			Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Probability of Occurence	Context	Significance	Level of Confidence
Construction Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-As)	Development and dewatering of pits Development and use of WRSFs	Phased mine development and progressive reclamation Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	OW	LT	MRE	R	L	L	NS	HCo
Operation Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-As)	Development, dewatering, and subsequent backfilling of pits Development and use of WRSFs Development and use of HLF and treatment facility Use of engineered	Phased mine development and progressive reclamation Waste rock management Management of potential ARD Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	OW	LT	MRE	R	L	L	NS	HCo

Potential Residual Adverse Effects	Contributing Project Activities	Proposed Mitigation Measures	Residual Effects Characterization (see Notes for details)										
			Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Probability of Occurence	Context	Significance	Level of Confidence
Closure and Reclamation Phase													
No residual effect predicted	–	–	–	–	–	–	–	–	–	–	–	–	–
Post-closure Phase													
No residual effect predicted	–	–	–	–	–	–	–	–	–	–	–	–	–

Notes:

Direction P = Positive, A= Adverse
Magnitude: LM = Low magnitude, MM = Moderate magnitude, HM = High magnitude
Geographic Extent: PA = Project area, LAA = Local Assessment Area, RAA = Regional Assessment Area
Timing: OW = Open-water period, IC = Ice-cover period, YR = Year-round
Duration: ST = Short-term, MT = Medium-term, LT = Long-term
Frequency: SI = Single event; MIE = Multiple irregular event; MRE = multiple regular event; CF = Continuous
Reversibility: R = Fully reversible, I = Irreversible
Probability of Occurrence: L = Likely, U = Unlikely
Context: L=Low, M=Moderate, H=High
Significance: NS = Not-Significant, S = Significant
Level of Confidence: LCo = Low confidence, MCo = Moderate confidence, HCo = High confidence
– = Not relevant to the assessment

Table 4.4-11 Summary of Potential Residual Adverse Effects for Surface Water Quality in Halfway Creek

Potential Residual Adverse Effects	Contributing Project Activities	Proposed Mitigation Measures	Residual Effects Characterization (see Notes for details)										
			Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Probability of Occurence	Context	Significance	Level of Confidence
Construction Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-U)	Development and dewatering, of pits Development and use of WRSF	Phased mine development and progressive reclamation Waste rock management Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	OW	LT	MR E	I	L	L	NS	MCo
Operation Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (T-U)	Explosives use from site development Development and dewatering, of pits Development and use of WRSF	Phased mine development and progressive reclamation Waste rock management Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	LM	LAA	OW	LT	MR E	I	L	L	NS	MCo
Closure and Reclamation Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (nitrate, T-U, T-Zn)	Explosives use from site development Development and dewatering, of pits Development and use of WRSF Cessation of HLF active treatment	Phased mine development and progressive reclamation Waste rock management Surface water and groundwater protection and management Mine site area water management Monitoring and adaptive management	A	MM	LAA	OW	LT	MR E	I	L	L	NS	MCo

Potential Residual Adverse Effects	Contributing Project Activities	Proposed Mitigation Measures	Residual Effects Characterization (see Notes for details)										
			Direction	Magnitude	Geographic Extent	Timing	Duration	Frequency	Reversibility	Probability of Occurence	Context	Significance	Level of Confidence
Post-closure Phase													
Surface water quality increases above corresponding WQG or proposed SSWQO (nitrate, T-U)	Site closed – ongoing effects from activities in prior phases	Monitoring and adaptive management	A	MM	LAA	OW	LT	MRE	I	L	L	NS	MCo

Notes:

– = Not relevant to the assessment
Direction P = Positive, A= Adverse
Magnitude: LM = Low magnitude, MM = Moderate magnitude, HM = High magnitude
Geographic Extent: PA = Project area, LAA = Local Assessment Area, RAA = Regional Assessment Area
Timing: OW = Open-water period, IC = Ice-cover period, YR = Year-round
Duration: ST = Short-term, MT = Medium-term, LT = Long-term
Frequency: SI = Single event; MIE = Multiple irregular event; MRE = multiple regular event; CF = Continuous
Reversibility: R = Fully reversible, I = Irreversible
Probability of Occurrence: L = Likely, U = Unlikely
Context: L=Low, M=Moderate, H=High
Significance: NS = Not-Significant, S = Significant
Level of Confidence: LCo = Low confidence, MCo = Moderate confidence, HCo = High confidence

5.0 ASSESSMENT OF CUMULATIVE EFFECTS

The effects of other projects and activities that have been carried out prior to the Project are reflected in background water quality (i.e. the Natural Case). The potential for Project-related effects to combine with the effects of other projects and activities that have been carried out prior to the Project (i.e. change from the Natural Case) are described in Section 4.2.2.1 (i.e. the Base Case model results). These are integrated into the Project's residual effects, which are described by catchment in sections 4.2.2.2 through 4.2.2.6.

The Project is predicted to cause residual effects in Latte Creek, lower Coffee Creek (below the Latte Creek confluence), YT-24 Creek and Halfway Creek. No residual effects are predicted to occur in Yukon River in association with the Project. More specifically, the predicted residual effects for surface water quality are an increase in the concentrations of:

- Nitrate (in Halfway Creek)
- Dissolved Aluminum (in Latte, YT-24 and Halfway Creeks)
- Total Arsenic (in YT-24)
- Total Chromium (in Halfway Creek)
- Total Copper (in Latte, YT-24 and Halfway Creeks)
- Total Uranium (in Latte Creek and Halfway Creeks), and
- Zinc (in Halfway Creek).

This section describes the potential for the residual effects of the Project to combine with the incremental effects of other certain and reasonably foreseeable projects and activities that will be carried out (i.e. those not already considered in the Base Case).

The projects and activities that were included in this evaluation were identified in consultation with government agencies, affected First Nations and local communities, and stakeholders. Reasonably foreseeable projects that were identified are those for which proposals have been submitted to YESAA, or which have been entered into another formal project approval or permitting process. The Project and Activity Inclusion List is discussed in more detail in **Section 5.0** Assessment Methodology, and is included as **Appendix 5-B** of the project proposal.

5.1 PROJECT-RELATED RESIDUAL EFFECTS

A residual effect was classified as a predicted Project-related increase to the concentration of water quality indicators above corresponding WQGs for the protection of freshwater aquatic life, or measurably above the Natural Case for parameters which are naturally-elevated above WQGs. The predicted residual effects are limited to increases in the concentrations of:

- Dissolved aluminum and uranium in Latte Creek;
- Dissolved aluminum, arsenic and copper in YT-24; and
- Nitrate, dissolved aluminum, chromium, copper, uranium and zinc in Halfway Creek.

5.2 OTHER PROJECTS AND ACTIVITIES

Other certain or reasonably foreseeable projects and activities that may have relevance to the Coffee Gold Project were compiled for further consideration in **Appendix 5-B** of the Project Proposal. The spatial and temporal boundaries used to identify potential projects are any projects or activities that may occur within the Latte, YT-24 and Halfway Creek catchments from present to the year 2100.

The only project identified that could potentially cause effects that would interact with these residual effects to surface water quality from the Coffee Gold Project is further mineral exploration on the Archer, Cathro & Associates Ltd. Dan Man Project, on mineral tenure on the lower reaches of YT-24 and Halfway Creeks. The last exploration activity at Dan Man occurred in 2011, and consisted of a five-hole diamond drill program that targeted a 300 m by 100 m area. It is possible that additional exploration of a similar scale may be undertaken by the present or future owner of this mineral tenure. The information currently available does not indicate that a larger-scale exploration program or mine development are likely.

5.3 POTENTIAL CUMULATIVE EFFECTS

Further exploration activity is expected to create negligible changes to surface water quality. Any changes would be of small magnitude, temporary and localized. No cumulative change is expected to occur as a result of this interaction. Consequently, the cumulative effects assessment for surface water quality concludes that other projects and activities will not contribute to the Project-related residual effects to result in residual cumulative effects.

6.0 SUMMARY OF EFFECTS ASSESSMENT ON SURFACE WATER QUALITY

In this section, the overall results of the effects assessment are highlighted, including mitigation measures to be implemented to eliminate, reduce or control adverse effects (**Section 6.1**), residual effects of the Project (**Section 6.2**), residual cumulative effects due to interactions with other projects and activities (**Section 6.3**), and residual effects due to accidents and malfunctions (**Section 6.4**).

6.1 MITIGATION

The mitigation measures incorporated into the Project design are extensive, and in concert, they serve to substantially reduce the potential effects on surface water quality that might otherwise be expected to result from the development of a mine. Key mitigation measures include phased mine development and progressive reclamation, and installation of a water treatment plant to treat drainage from the HLF as it drains down, with operation of the plant currently anticipated to begin in Year 9.

Phased development of the mine will reduce pre-stripping requirements in the early years of the mine, In addition to providing flexibility in the schedule, maximizing ore grade, and allowing the HLF to be maintained at full production capacity. This will minimize the spatial and temporal extent of surface disturbance, thereby minimizing potential sedimentation and erosion and weathering of disturbed mine materials. Progressive reclamation and closure activities will begin as soon as mining at the Double Double pit has been completed in Year 2 and will continue throughout the mine life.

A water treatment facility will be installed and operated beginning in Year 9, to treat surplus water from the HLF. This will reduce the concentration of parameters in contact water associated with leaching from HLF residues, explosives residues, and disturbed mine materials, prior to discharge to the receiving environment. Treated water will initially be recycled to the heap leach as rinse water, and subsequently discharged to the environment once the quality of treated water is adequate.

In addition to the various mitigation measures that will be implemented, a range of management plans will be employed in the day-to-day operation of the site. These management plans will codify best management practices for the protection of surface water quality.

6.2 RESIDUAL PROJECT EFFECTS

Based on the mitigation measures summarized above, the following residual Project effects were incorporated into a Goldsim-platform water quality model for the purpose of evaluating potential Project effects to surface water quality:

- Leaching from disturbed mine materials/waste
- Leaching of nitrogen residues generated from blasting
- Leaching of HLF residues, and
- Groundwater and surface water interactions and seepage.

The model predicts concentrations for 25 indicators of residual Project effects (i.e., water chemistry parameters including anions, nutrients and metals) for key locations within the receiving environment on a mean monthly basis for the life of mine. Predicted concentrations for the Base Case model scenario, reflecting expected case flow conditions and geochemical source terms associated with Project effects above, were characterized and assessed following the approach outlined in **Section 4.4.1**.

Overall, residual Project effects are predicted to occur in Latte Creek (associated with T-U), YT-24 (associated with T-As), and Halfway Creek (associated with nitrate, T-U and T-Zn). No residual effects are predicted to occur in Coffee Creek, downstream of the Latte Creek confluence, or in the Yukon River. Residual Project effects are summarized below by catchment, alongside the determination of effect significance and likelihood.

6.2.1 Latte Creek

Residual effects to surface water quality in Latte Creek are predicted in the Base Case associated with a Project-related increase to T-U above its corresponding PSSWQO. Overall, potential residual effects to Latte Creek are considered not significant based on the effect characteristics summarized in **Section 4.4.2.2**. This rating is assigned a high confidence level, reflecting a high level of certainty in the water quality model predictions, as well as site-specific conditions.

6.2.2 YT-24

Residual effects to surface water quality in YT-24 are predicted in the Base Case associated with a Project-related increase to T-As above its corresponding WQG. Overall, potential residual effects from these parameters in Base Case Conditions are considered not significant based on the effect characteristics summarized in **Section 4.4.2.4**.

This rating is assigned a high confidence level, given the relative level of certainty in the water quality model predictions and the level of understanding of the Project receiving environment. It is further supported by the conservatism integrated into the WQG for T-As, and the low-magnitude and irregular frequency of WQG exceedances predicted to occur in YT-24. Halfway Creek

Residual effects to surface water quality in Halfway Creek are predicted in the Base Case associated with a Project-related increase to nitrate, T-U, and T-Zn above their corresponding WQGs or PSSWQO. Overall, potential residual effects from these parameters in Base Case Conditions are considered not significant based on the effect characteristics summarized in **Section 4.4.2.5**.

Generally, this rating for all parameters is associated with a moderate to high confidence rating, given the relative level of certainty in the baseline dataset for Halfway Creek, the current understanding of the receiving environment, and the level of conservatism integrated into the WQGs as residual effect screening benchmarks.

6.2.3 YUKON RIVER

No residual effects are predicted to occur in the Yukon River based on Base Case modelling results of YRdsCC45, YRdsYT24, and YRdsHC50. The model results show a negligible change to Yukon River water quality as a result of Project discharges.

6.3 RESIDUAL CUMULATIVE EFFECTS

Because no residual effects are predicted to occur in the Yukon River from Base Case Project conditions, cumulative effects to the Yukon River are not predicted.

6.4 RESIDUAL EFFECTS DUE TO ACCIDENTS AND MALFUNCTIONS

An accident or malfunction could occur at any time, and the accidents considered could occur in any Project phase. In general, any accident or malfunction that may occur is not expected to result in significant residual effects to surface water quality. See Section 28.0 of the Project Proposal for more information on the residual effects that may occur as a result of accidents and malfunctions.

7.0 EFFECTS MONITORING AND ADAPTIVE MANAGEMENT

Monitoring is required to verify water quality predictions, and to identify any unanticipated effects on surface water quality that may occur through life of mine. Monitoring will include surface water quality within the mine site, at effluent discharge points, and in the receiving environment.

Monitoring is required to verify water quality predictions, and to identify any unanticipated effects on surface water quality that may occur through life of mine. Monitoring will include surface water quality within the mine site, at effluent discharge points, and in the receiving environment. The surface water quality monitoring program is intended:

- To verify and update water quality predictions for all phases of the Project, based on monitoring results, as necessary.
- To assess compliance with applicable water quality discharge limits for mine site effluent, and
- To assess whether any mitigation or adaptive management is required.

7.1 MONITORING SYSTEM OVERVIEW

A generic surface water quality monitoring program is discussed below for the Coffee Gold Project, with a focus on monitoring concepts as they relate to Mine Site monitoring, Effluent Monitoring and Receiving Environment Monitoring. During Construction, surface water quality monitoring is anticipated to evolve and expand as mine design concepts, construction schedules and regulatory requirements are refined. Additional monitoring initiatives may be required during Operation and Closure Phases. Surface water quality monitoring requirements will be reduced following successful reclamation and closure of the mine site. Design and delivery of future monitoring activities will require the involvement of regulatory agencies that have jurisdiction over water-related issues, affected First Nations, and coordinated efforts by mine staff.

7.1.1 MINE SITE MONITORING

Water quality parameters should not exceed predictions at those locations within the mine site where water will be collected and monitored. Mine site monitoring will be undertaken to assess the quality of surface water that is affected by the various mine facilities. It is required primarily to verify geochemical source terms and to ensure that the water management system is effective. As such, it includes monitoring of pit sumps and water quality of seepage from waste rock storage facilities (WRSFs).

7.1.2 EFFLUENT MONITORING

Effluent monitoring is intended to assess the quality of surface water that collects in sediment control ponds, located downgradient of mine infrastructure that will be discharged to the receiving environment. Two sediment control ponds are proposed (the Alpha Pond and Facility Pond) , and surface water quality will be monitored at both. The quality of water treatment plant effluent will also be monitored once the water treatment plant is operated, currently anticipated to start in Year 9. Monitoring will be undertaken to ensure compliance with regulatory requirements, and to identify any potential upset conditions.

7.1.3 Receiving Environment Monitoring

Surface water quality monitoring will include monitoring at selected stations on Latte Creek, Coffee Creek, YT-24, Halfway Creek, and on the Yukon River, as well as Independence Creek, the latter of which currently serves as the undisturbed control drainage. Water quality in the receiving environment downstream of the mine will reflect the ultimate effects of the mine on the relevant intermediate and valued components (ICs and VCs, respectively). Surface water quality in the receiving environment is expected to be subject to specific regulatory requirements.

7.2 Objectives

7.3 Methods

The methods employed for the existing program will continue through operations and the post-mining phase. Water quality sampling is undertaken in accordance with the *British Columbia Field Sampling Manual* (BC Ministry of Environment, 2013). A YSI Sonde handheld instrument is used to obtain *in situ* measurements of temperature, pH, specific conductance, dissolved oxygen (DO), and oxidation-reduction potential (ORP) at the time and location that water quality samples are taken. Samples are collected and shipped to an accredited laboratory for analysis.

7.3.1 Analytical Procedures

Samples are shipped to an accredited laboratory and are analyzed for physical parameters, major ions, nutrients, total and dissolved organic carbon, weak acid dissociable (WAD) cyanide, and total and dissolved metals. The full list of parameters that are analyzed, and detection limits, are provided in **Table 7.3-1** below.

Table 7.3-1 Analytical Parameter List and Reportable Detection Limits

Analysis		Reportable Detection Limit
Physical Parameters	**Unit**	
Conductivity	µS/cm	1.0
Hardness (as $CaCO_3$)	mg/L	0.5
pH	pH	0.01 unit
Total Suspended Solids (TSS)	mg/L	1.0
Total Dissolved Solids (TDS)	mg/L	10.0
Turbidity	NTU	0.1
Major Ions and Nutrients		
$Alkalinity_{Total}$ (as $CaCO_3$)	mg/L	0.5
$Alkalinity_{PP}$ (as $CaCO_3$)	mg/L	0.5
Bicarbonate (HCO_3)	mg/L	0.5
Cabonate (CO_3)	mg/L	0.5
Chloride (Cl)	mg/L	0. 5

Analysis		Reportable Detection Limit
Physical Parameters	**Unit**	
Sulphate (SO_4)	mg/L	0.5
Fluoride (F)	mg/L	0.01
Nitrate (as N)	mg/L	0.002
Nitrite (as N)	mg/L	0.002
Total Ammonia (as N)	mg/L	0.005
Nitrate plus Nitrite (as N)	mg/L	0.002
Total Phosphorus as P	µg/L	0.002
Cyanide		
Weak acid dissociable cyanide (CN_{WAD})	mg/L	0.0005
Organic Carbon		
Total Organic Carbon (TOC)	mg/L	0.5
Dissolved Organic Carbon (DOC)	mg/L	0.5
Total and Dissolved Metals		
Aluminum (Al)	µg/L	0.5
Antimony (Sb)	µg/L	0.02
Arsenic (As)	µg/L	0.02
Barium (Ba)	µg/L	0.02
Beryllium (Be)	µg/L	0.02
Bismuth (Bi)	µg/L	0.01
Boron (B)	µg/L	10
Cadmium (Cd)	µg/L	0.005
Calcium (Ca)	mg/L	0.05
Chromium (Cr)	µg/L	0.1
Cobalt (Co)	µg/L	0.005
Copper (Cu)	µg/L	0.05
Iron (Fe)	µg/L	1.0
Lead (Pb)	µg/L	0.005
Lithium (Li)	µg/L	0.5
Magnesium (Mg)	mg/L	0.05
Manganese (Mn)	µg/L	0.05
Mercury (Hg)	µg/L	0.002
Molybdenum (Mo)	µg/L	0.5
Nickel (Ni)	µg/L	0.02
Potassium (K)	mg/L	0.05
Selenium (Se)	µg/L	0.04
Silicon (Si)	mg/L	50

Analysis		Reportable Detection Limit
Physical Parameters	Unit	
Silver (Ag)	µg/L	0.005
Sodium (Na)	mg/L	0.05
Strontium (Sr)	µg/L	0.05
Thallium (Tl)	µg/L	0.002
Tin (Sn)	µg/L	0.2
Titanium (Ti)	µg/L	0.5
Uranium (U)	µg/L	0.002
Vanadium (V)	µg/L	0.2
Zinc (Zn)	µg/L	0.1

7.3.2 Quality Assurance / Quality Control

Quality Assurance / Quality Control (QA/QC) measures include use of field blanks (one per sampling event), duplicate samples (approximately 1 in 10), and travel blanks (one per sampling event). Both field and travel blanks are prepared using distilled – deionized water (DDW), which will be supplied by an accredited laboratory.

7.3.3 Toxicity

The surface water quality monitoring will include sampling and analysis to evaluate acute and chronic toxicity of mine effluent. The details of the program, including the timing, frequency, locations, and specific toxicity tests to be undertaken will be determined in due course, and will be discussed in detail in the Environmental Effects Monitoring (EEM) study that will be developed for the Project.

7.3.4 Timing, Frequency and Duration

In general, water quality monitoring will be undertaken year-round. It may not be possible to obtain water quality samples at some locations at times when there is inadequate flowing water, when dry conditions prevail in summer or early autumn, or in winter, when smaller watercourses may be frozen, and aufeis prevalent.

In general, it is intended that water quality monitoring be undertaken on a quarterly basis within the mine site, weekly at effluent discharge locations, and monthly in the receiving environment. Quarterly samples are expected to be adequate to evaluate whether the quality of mine contact water is consistent with predictions. Weekly monitoring of mine effluent is anticipated to be required pursuant to the MMER. Monthly monitoring in the receiving environment is expected to be sufficient for evaluating potential effects, and to verify that water quality is consistent with predictions.

Surface water quality monitoring has been undertaken for several years to establish baseline conditions, and will be continued through construction, operations and the post-mining period of the reclamation and closure phase. The monitoring program will be scaled back, as appropriate, as the mine site is reclaimed.

7.4 LOCATIONS

Monitoring will be undertaken to determine water quality at key facilities within the mine site, in sediment control ponds prior to discharge, and in the receiving environment. Surface water quality monitoring stations are listed in Section 3.2 above.

7.4.1 MINE SITE

Water quality samples will be obtained from:

- Pit sumps;
- The toe of the ore stockpile;
- The toe of the WRSFs (Alpha and Beta).

The purpose of this sampling is to verify geochemical source terms used and to update water quality predictions. It is proposed that this sampling be undertaken on a quarterly basis.

7.4.2 MINE EFFLUENT

Water quality samples will be obtained from both the Alpha Pond and the Facility Pond. It is proposed that this sampling be undertaken on a weekly basis. The purpose of this sampling is to verify that mine contact water meets regulatory requirements prior to discharge.

7.4.3 RECEIVING ENVIRONMENT

Water quality samples will be obtained downstream of the Mine Site in Latte Creek, YT-24 Creek and Halfway Creek. It is anticipated that this sampling will be undertaken on a monthly basis.

7.4.4 INDEPENDENCE CREEK AND YUKON RIVER

Monitoring will continue on Independence Creek and on the Yukon River up and downstream of the mine.

7.5 IMPLEMENTATION

Responsibility for implementation of the surface water quality monitoring program will be assigned to site personnel or qualified professionals.

7.5.1 Roles and Responsibilities

Following the above, responsibilities for on-site and external consultants are summarized below.

7.5.1.1 Site Personnel

Site personnel will be responsible for the following tasks related to the surface water quality monitoring plan:

- Acquisition of the necessary equipment (YSI meter, etc.) and supplies (coolers, sample bottles, labels, travel blanks, Chain-of-Custody forms, etc.), including any specialized equipment or supplies that may be needed from time to time
- Scheduling site sampling, sensor / meter maintenance and calibration
- Personal health and safety, including hazard identification and avoidance, wearing appropriate personal protective equipment (PPE), etc.
- Initial data management activities including QA/QC of data, archiving and backup
- Compilation of data for dissemination to other qualified professionals
- Training of other site staff to ensure redundancy in the monitoring program, and
- Review and updates of the monitoring protocols, manuals, etc. as necessary, and/or as required by permit and license conditions.

7.5.1.2 Qualified Professionals

External consultants (i.e., qualified professionals engaged by Goldcorp) will be responsible for the following tasks related to the collection and interpretation of surface water quality data:

- Secondary QA/QC of data collected by the program
- Updates of existing analyses and new analyses that utilize the site data, as required
- Maintaining a record of changes made to the data following the QA/QC exercise, and a record of suggested alterations to the monitoring program (including frequency, sensor types, monitoring locations, monitoring and data management protocols, etc.), and
- Maintaining backups of all data and associated maintenance records, field notes, reports, etc. on a corporate server.

7.6 Data Management and Reporting

Once field and laboratory analytical data has been obtained, it will be entered by the responsible site personnel into a standardized surface water quality database. This will form the primary record, and any adjustments or corrections that are performed on this data will be saved as separate files, to ensure that the original data records remain unaltered. All data and associated field notes will be stored in standard electronic format.

Site personnel will routinely evaluate the database to identify any potential anomalies or errors in data entry. Preparation of monthly reports will help to identify trends, and any anomalous results in water quality results, as further described below. It is anticipated that both monthly, and more detailed annual, water quality reports will be required as conditions of the Water Use License(s) that will be issued for the Coffee Gold Project.

7.6.1.1 Monthly Data Reports

Submission of monthly water quality monitoring data reports is typically required as a condition of Water Use Licenses issued by the Yukon Water Board. These reports will include monitoring data, routine ***statistical compilation, and notes regarding the QA/QC aspects of the monitoring program.***

7.6.1.2 Annual Interpretive Reports

Annual interpretive reports will presumably be a permit or licence requirement for the Project. It is anticipated that annual interpretive reports will summarize water quality monitoring data, including both field data and laboratory analyses. The reports will also identify trends, anomalies, and other relevant information.

Any significant changes to the monitoring network, such as addition or deletion of monitoring stations, or change to analytical parameters, for example, will be noted, along with a rationale for the changes. If necessary, recommendations will be made concerning upgrades or changes that are deemed necessary for the following year, along with the rationale.

Finally, the annual report will relate the site-data to water quality predictions, benchmark objectives, and guidelines, as appropriate. The annual report will make note of instances of any exceedances, and the results of the investigation undertaken to identify the cause, whether an event (e.g., large rainfall event, a “near-miss” associated with water management infrastructure or protocols) or trend (such as sediment pond water quality that consistently exceeds predictions, for example).

7.7 TRIGGERS / INDICATORS

Specific concentrations that would constitute anomalous water quality or a trend at a sediment control pond that would require investigation will be established in due course. These “trigger” level concentrations will likely be established for:

- Turbidity and/or TSS - field and lab indication, respectively, of excessive erosion and potential sedimentation and/or atmospheric deposition (dust fall)
- pH and sulphate - key indicators of weathering of geologic materials
- Cyanide species – key indicator of leaching of HLF residues and
- Nitrogen species – key indicators of leaching of blasting residues.

In addition, trigger levels may be established for key metals of potential concern.

Measurement of concentrations that meet or exceed the established trigger level thresholds will result in an investigation, as noted above, and in some cases may trigger implementation of specific, pre-determined contingency measures. The investigation would focus on identifying the source causing water quality degradation, and implementing mitigation following the hierarchy of (i) elimination, (ii) reduction, (iii) control, (iv) isolation, and (v) protection.

Pre-determined contingency measures may be implemented in extraordinary circumstances, such as in the case of a serious or malfunction, for example. Pre-determined contingency measures that may be considered include, but are not necessarily limited to:

- Temporarily routing degraded water to the process plant for use as make-up process water (assuming that it would not impair the treatment process), or for dust suppression (assuming that this use would not cause any other environmental concern).
- Recirculation of surface water from sediment control ponds back to open pits (by manual pumping the water), to allow additional settling, dilution, and/or some form of treatment prior to discharge. This could only be considered once it has been confirmed that excess water can safely be accommodated within an open pit (whether active or inactive) without causing any risk to worker health and safety, geotechnical concern (i.e. pit or bench stability), or any other potential environmental concern.

These are examples of potential contingency measures that would only be implemented in extraordinary circumstances, and would not be relied upon as part of normal operations. The adaptive management approach for surface water quality will be refined through the permitting process, and as experience is gained in the Construction and Operation phases.

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