

Chapter 11 - Surface Water Quality Assessment

Crown Mountain Coking Coal Project
Application for an Environmental Assessment Certificate /
Environmental Impact Statement

Table of Contents

11. Surface Water Quality Assessment	11-1
11.1 Introduction	11-1
11.1.1 Regulatory and Policy Setting	11-2
11.2 Scope of the Assessment	11-4
11.2.1 Valued Components and Measurement Indicators	11-4
11.2.2 Indigenous and Stakeholder Consultation	11-5
11.2.3 Assessment Boundaries	11-5
11.2.3.1 Spatial Boundaries	11-5
11.2.3.2 Temporal Boundaries	11-8
11.2.3.3 Administrative Boundaries	11-8
11.2.3.4 Technical Boundaries	11-12
11.3 Regional and Local Overview	11-12
11.3.1.1 Regional Environmental	11-13
11.3.1.2 Local Environment	11-13
11.4 Existing Conditions	11-14
11.4.1 Existing Regional and Local Information	11-14
11.4.1.1 Regional Information	11-14
11.4.1.2 Local Surface Water Quality	11-17
11.4.1.3 Local and Regional Potable Surface Water Resources	11-18
11.4.1.4 Transboundary Environment	11-18
11.4.2 Baseline Program	11-18
11.4.2.1 Methods	11-18
11.4.2.2 Results	11-21
11.5 Project Effects Assessment	11-35
11.5.1 Thresholds for Determining Significance of Residual Effects	11-35
11.5.2 Project Effects	11-35
11.5.2.1 Project Interactions	11-35
11.5.2.2 Discussion of Potential Effects	11-43
11.5.2.3 Transboundary Effects	11-50
11.5.3 Mitigation Measures	11-51
11.5.3.1 Mitigation Measures for Change in Surface Water Quality from Non-Contact Water Runoff	11-52
11.5.3.2 Mitigation Measures for Change in Surface Water Quality from Dust Deposition	11-52
11.5.3.3 Mitigation Measures for Change in Surface Water Quality from Mine Site Drainage	11-53
11.5.3.4 Mitigation Measures for Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects	11-55
11.5.3.5 Mitigation Measures for Change in Surface Water Quality from Surface Water – Groundwater Interactions	11-56
11.5.3.6 Mitigation Measures for Change in Surface Water Quality from Sediment Pond Discharge	11-57
11.5.3.7 Summary of Mitigation Measures for Surface Water Quality	11-58
11.5.4 Characterization of Residual Effects, Significance, Likelihood, and Confidence	11-63

11.5.4.1	Surface Water Quality Assessment Methods	11-63
11.5.4.2	Potential Residual Effects Assessment	11-70
11.5.4.3	Characterization of Residual Effects.....	11-93
11.5.4.4	Likelihood and Confidence.....	11-97
11.5.4.5	Summary of Residual Effects Assessment	11-97
11.6	Cumulative Effects Assessment	11-99
11.6.1	Overview of Residual Effects.....	11-99
11.6.2	Assessment Boundaries.....	11-99
11.6.2.1	Spatial Boundaries.....	11-99
11.6.2.2	Temporal Boundaries	11-100
11.6.2.3	Use of Temporal Cases	11-100
11.6.2.4	Administrative Boundaries	11-100
11.6.2.5	Technical Boundaries.....	11-100
11.6.3	Identifying Past, Present, and Reasonably Foreseeable Projects and/or Activities.....	11-102
11.6.4	Identification of Cumulative Effects	11-107
11.6.5	Mitigation for Cumulative Effects	11-109
11.6.6	Characterization of Residual Cumulative Effects	11-112
11.6.6.1	Change in Surface Water Quality from Sediment Pond Discharge	11-112
11.6.7	Summary of Cumulative Effects Assessment.....	11-118
11.7	Follow-up Strategy	11-120
11.8	Summary and Conclusions.....	11-121
11.9	References	11-122

Figures

Figure 11.2-1:	Aquatic Local Study Area (LSA).....	11-6
Figure 11.2-2:	Aquatic Regional Study Area (RSA).....	11-7
Figure 11.4-1:	Surface Water Quality Sampling Stations	11-19
Figure 11.4-2:	Overview of Surface Water Quality Key Parameters.....	11-22
Figure 11.5-1:	Project Footprint Infrastructure	11-40
Figure 11.5-2:	Aquatic Local Study Area Water Quality Nodes	11-67
Figure 11.5-3:	Aquatic Regional Study Area Water Quality Nodes.....	11-68
Figure 11.5-4:	Water Quality Predictions for Grave Creek Node GC-5	11-76
Figure 11.5-5:	Water Quality Predictions for Grave Creek Node GC-3.....	11-77
Figure 11.5-6:	Water Quality Predictions for Grave Creek Node GC-2.....	11-78
Figure 11.5-7:	Water Quality Predictions for Grave Creek Node GC-1	11-79
Figure 11.5-8:	Water Quality Predictions for West Alexander Creek Node AC-6.....	11-82
Figure 11.5-9:	Water Quality Predictions for Alexander Creek Node AC-3.....	11-84
Figure 11.5-10:	Water Quality Predictions for Alexander Creek Node AC-2.....	11-85
Figure 11.5-11:	Water Quality Predictions for Alexander Creek Node AC-1.....	11-86
Figure 11.5-12:	Water Quality Predictions for Elk River Node EV_ER1	11-89
Figure 11.5-13:	Water Quality Predictions for Elk River Node RG_ELKORES	11-90
Figure 11.5-14:	Water Quality Predictions for Lake Koocanusa Node RG_DSELK.....	11-92
Figure 11.6-1:	Present and Reasonably Foreseeable Projects and Activities with the Potential to Contribute to Cumulative Effects in the Aquatic RSA.....	11-106

Figure 11.6-2:	Selenium Predictions for Elk River Node EV_ER1, With and Without Climate Change	11-110
Figure 11.6-3:	Estimated Nitrate, Selenium, and Sulphate Concentrations in Michel Creek Downstream of Erickson Creek	11-114

Tables

Table 11.1-1:	Federal Regulatory Considerations and Guidance Documents for Surface Water Quality	11-2
Table 11.1-2:	Provincial Regulatory Considerations and Guidance Documents for Surface Water Quality.....	11-2
Table 11.2-1:	Measurement Indicators and Effects Pathways for Surface Water Quality	11-4
Table 11.2-2:	Temporal Boundaries for the Project Effects Assessment.....	11-8
Table 11.2-3:	Summary of Federal, Provincial, and Regional Water Quality Guidelines for the Protection of Freshwater Aquatic Life	11-9
Table 11.2-4:	Proposed Coal Mining Effluent Regulation Limits for New and Existing Mines.....	11-12
Table 11.4-1:	Summary of Monthly Average Concentration Limits For Selenium, Nitrate, and Sulphate at Compliance Points for Current Teck Coal Mining Operations (ENV, 2020b)	11-16
Table 11.4-2:	Summary of Daily Maximum Concentration Limits for Selenium and Nitrate at Compliance Points for Current Teck Coal Operations (ENV, 2020b)	11-17
Table 11.4-3:	Location of Surface Water Quality Sampling Stations in Order of Surface Water Flow Path.....	11-20
Table 11.4-4:	Summary of Exceedances of the B.C. WQG Short-Term and CWQG Short-Term and Long-Term	11-23
Table 11.4-5:	Summary of Exceedances of the EVWQP Long-Term Water Quality Targets.....	11-27
Table 11.4-6:	Summary of Field Parameter Results	11-30
Table 11.5-1:	Project-Surface Water Quality Interaction Matrix and Ranking	11-36
Table 11.5-2:	Potential Effects on Surface Water Quality	11-42
Table 11.5-3:	Summary of Proposed Mitigation Measures related to Surface Water Quality	11-59
Table 11.5-4:	Water Quality Model Reporting Nodes	11-65
Table 11.5-5:	Site Wide Water Quality Model Simulations	11-69
Table 11.5-6:	Screening Threshold Levels.....	11-71
Table 11.5-7:	Summary of Predicted B.C. Water Quality Guideline Exceedances at Local and Regional Water Quality Nodes	11-74
Table 11.5-8:	Summary of Residual Effects on Surface Water Quality.....	11-98
Table 11.6-1:	50th and 95th Percentile Background and Predicted Water Quality in the Elk River and Lake Koochanusa over the Project Life	11-101
Table 11.6-2:	Surface Water Quality Interactions Matrix for Potential Cumulative Effects.....	11-102
Table 11.6-3:	List of Projects and Activities with Potential to Adversely Contribute to Cumulative Effects on Surface Water Quality	11-107
Table 11.6-4:	Summary of Long-term Water Quality Targets in the Elk Valley Water Quality Plan	11-108
Table 11.6-5:	Summary of Cumulative Effects on Surface Water Quality	11-119
Table 11.7-1:	Summary of Proposed Surface Water Quality Monitoring Locations	11-120

Appendices

Appendix 11-A.	Summary of Consultation Feedback on Surface Water Quality
Appendix 11-B.	Surface Water Quality Baseline Report
Appendix 11-C.	Geochemical Baseline
Appendix 11-D.	Calcification Assessment
Appendix 11-E.	Water Mitigation Technology Readiness Review
Appendix 11-F.	Water Quality Prediction Model
Appendix 11-G.	Water Quality Prediction Summary Statistics
Appendix 11-H.	Interim and Main Sediment Pond 50 th and 95 th Percentile Geochemical Charts
Appendix 11-I.	Mass Comparison of Nitrate, Selenium, and Sulphate Contributions in Michel Creek

11. Surface Water Quality Assessment

11.1 Introduction

Surface water is a key component of the biophysical environment. Surface water quality is essential to the maintenance of aquatic ecosystems, vegetation, wildlife, and human health. Water quality constitutes the physical, chemical, biological, and aesthetic characteristics of water as determined by regional and local factors including surficial and bedrock geology, rock weathering, surface transport, biological processes, and anthropogenic influences (Khatri and Tyagi, 2015). The physical and chemical compositions of water and sediment co-vary, with factors such as pH and temperature driving a dynamic exchange of molecules between the water column and underlying sediments (Khatri and Tyagi, 2015).

Given the complex relationship between surface water quality and the natural environment, surface water quality was identified as an intermediate valued component (VC) for the Project in the Application Information Requirements (AIR; Environmental Assessment Office [EAO], 2018) and as a component of the physical environment in the Guidelines for the Preparation of an Environmental Impact Statement for the Crown Mountain Coking Coal Project (EIS Guidelines; Canadian Environmental Assessment Agency, 2015), as it constitutes a pathway to receptor VCs such as fish, wildlife, vegetation, and humans. An understanding of surface water quality within and downstream of the Project is critical to the Project design, engineering, operations, and assessment and mitigation of potential environmental effects.

Surface water quality effects have linkages with intermediate and receptor VCs; these effects are primarily assessed in the following chapters:

- Chapter 9: Groundwater Assessment;
- Chapter 10: Surface Water Quantity Assessment;
- Chapter 12: Fish and Fish Habitat Assessment;
- Chapter 13: Landscapes and Ecosystems Assessment;
- Chapter 14: Vegetation Assessment;
- Chapter 15: Wildlife and Wildlife Habitat Assessment;

- Chapter 22: Human and Ecological Health Assessment; and
- Indigenous Communities discussed in Chapters 23 through 31.

11.1.1 Regulatory and Policy Setting

Provincial and federal regulatory requirements, policies, best management practices (BMPs), and guidance documents relevant to the management of surface water quality are summarized in Table 11.1-1 and Table 11.1-2. The surface water quality assessment considers both federal (i.e., Canadian Council of Ministers of the Environment [CCME] *Canadian Water Quality Guidelines [CWQG] for the Protection of Aquatic Life*; CCME, 2014) and provincial (i.e., *B.C. Approved Water Quality Guidelines [WQG]: Aquatic Life*; B.C. Ministry of Environment and Climate Change Strategy [ENV], 2019a) guidelines.

Table 11.1-1: Federal Regulatory Considerations and Guidance Documents for Surface Water Quality

Legislation/Guideline Name	Year	Description
Legislation		
<i>Canadian Environmental Protection Act</i>	1999	Provides pollution prevention measures for the protection of human and environmental health, while promoting sustainable development and use of resources in Canada.
<i>Canada Water Act</i>	1985	Provides for the management of water resources for the benefit and health of Canadians, including the prevention and remedy of pollution of waters.
<i>Fisheries Act</i>	1985, amended 2019	Establishes a framework for the management of fisheries resources and conservation of fish, including the prevention of pollution of fish habitat.
<i>International Boundary Waters Treaty Act</i>	1985	Pertains to the legal rights of parties pertaining to the impacts to and diversion of surface water in Canada which flow to the United States of America.
Guidelines		
<i>Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life</i>	2014	Comparison values for surface water quality for the protection of human health, aquatic life, and for agricultural use.

Table 11.1-2: Provincial Regulatory Considerations and Guidance Documents for Surface Water Quality

Legislation/Guideline Name	Year	Description
Legislation		
<i>Environmental Management Act</i>	2004	Regulates the development of policies for the management, protection, and use of the environment, including the development of land which is subject to flooding, and the management of water resources, fisheries, aquatic life, and waste disposal.

Legislation/Guideline Name	Year	Description
<i>Water Protection Act</i>	1996	The <i>Water Protection Act</i> confirms the province's ownership of surface and groundwater, defines limits for bulk water removal, and prohibits large-scale diversions of water between major provincial watersheds and/or to locations outside the province.
<i>Mines Act</i>	1996	Applies to permitting and operating procedures of mining operations in B.C., including environmental compliance (i.e., monitoring, metal leaching, acid rock drainage [ARD] generation and erosion control), health and safety and accident reporting, and abandonment and reclamation requirements.
<i>Riparian Areas Protection Act</i>	1997	Establishes directives to protect and enhance riparian zones in the vicinity of development, including industrial activity.
<i>Water Sustainability Act</i>	2014	Enforces the protection of stream and aquatic environment health and considers the potential effects on surface water and groundwater in land use decisions.
<i>Drinking Water Protection Act</i>	2001	Provides guidelines and directives for the use and development of water supply systems used for domestic purposes, for the protection of public health.
Guidelines		
<i>Ambient Water Quality Guidelines for Selenium Update</i>	2014	Provides updated Water Quality Guidelines (WQGs) for selenium in water for the protection of aquatic life. Analytical results can be compared to the guideline value and alert value for selenium in water for comparison purposes.
<i>Derivation of Water Quality Guidelines for the Protection of Aquatic Life in British Columbia</i>	2019	Provide reference for the derivation of WQG for use in B.C.
<i>Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators</i>	2016	Guidance which defines the requirements of baseline studies and monitoring programs for surface water and air effluents for proposed and operating mineral developments in B.C.
<i>B.C. Water Quality Guidelines (WQG; Approved and Working)</i>	2019; 2020	Provide short term maximum "acute" and long term "chronic" comparison values for surface water quality, for the protection of aquatic organisms against severe effects such as lethality due to short-term intermittent or transient exposures to contaminants, and from lethal and sub-lethal effects over long-term indefinite exposures.

Other relevant guidance includes the Elk Valley Water Quality Plan (EVWQP; Teck Resources Limited [Teck], 2014)), also known as the Elk Valley Area Based Management Plan, which was developed in response to a Ministerial Order issued to Teck in April 2013 under the British Columbia (B.C.) *Environmental Management Act* (2003) to manage the cumulative effects of coal mining on water quality in the Elk Valley. The EVWQP includes short-, medium-, and long-term water quality targets for four Order constituents as specified in the directive, namely: nitrate, sulphate, cadmium, and selenium. The Project is located with Management Unit (MU) 4 of the EVWQP; surface water quality compared to the EVWQP target values is discussed in Section 11.4.

The proposed federal *Coal Mining Effluent Regulations* (CMER) under the *Fisheries Act* (1985) will provide national baseline effluent quality standards for all new and existing coal mines upon their promulgation (Government of Canada, 2022). The proposed CMER include standards for suspended solids (TSS), total selenium, and total nitrate, as well as requirements related to pH and toxicity. The CMER will also set requirements for monitoring, reporting, and record keeping, including environmental effects monitoring provisions.

The Montana Department of Environmental Quality, with approval of the United States (U.S.) Environmental Protection Agency in 2021, has established site-specific selenium standards for Lake Koochanusa and the Kootenai River (Montana Department of Environmental Quality, 2022). The Montana Department of Environmental Quality is continuing to work with the B.C. ENV and the Lake Koochanusa Monitoring and Research Working Group to maintain and protect uses of the Lake; however, the Lake Koochanusa and Kootenai River selenium standards currently only apply to the portions of Lake Koochanusa located within the United States of America (U.S.A.) and are presented solely for context.

11.2 Scope of the Assessment

11.2.1 Valued Components and Measurement Indicators

Project activities during Construction and Pre-Production, Operations, Reclamation and Closure, and Post-Closure may influence surface water quality within and downstream of the Project footprint. Changes to surface water quality from mining activities may result in potential effects to receptor VCs, including aquatic health, vegetation, wildlife, and human and ecological health. Surface water quality measured through loadings and concentrations of metal and non-metal constituents were selected as the measurement indicators for surface water quality effects in the AIR (EAO, 2018). However, the Project effects assessment (Section 11.5) focuses only on concentrations of metals and non-metal constituents in surface water quality, as applicable federal and provincial water quality guidelines are based on concentrations. The cumulative effects assessment (Section 11.6) considers both concentrations and mass contributions (i.e., loadings), where regional information is available. The measurement indicators for the surface water quality VC are summarized in Table 11.2-1.

Table 11.2-1: Measurement Indicators and Effects Pathways for Surface Water Quality

Valued Component	Measurement Indicator	Effects Pathways
Surface Water Quality	<ul style="list-style-type: none"> Surface water quality measured through loadings and concentrations of metals and non-metal constituents in surface water (including constituents of interests from the EVWQP - selenium [Se], cadmium [Cd], nitrate [NO₃], and sulphate [SO₄]) 	VCs or VC groups for which surface water quality is an effects pathway include: <ul style="list-style-type: none"> Groundwater Quantity and Quality; Fish and Fish Habitat; Benthic Invertebrates; Terrestrial Ecosystems; Vegetation; Wildlife and Wildlife Habitat; Human Health; Wildlife Health; and Indigenous Communities.

11.2.2 Indigenous and Stakeholder Consultation

NWP engaged with Indigenous groups and conducted consultation with public stakeholders and regulators. A summary of all consultation and engagement activities undertaken to date is presented in Chapter 4. A summary of consultation feedback specific to surface water quality is presented in Appendix 11-A. Indigenous and stakeholder consultation feedback received was used to inform the surface water quality baseline program, evaluate baseline conditions, and inform the surface water quality modelling.

11.2.3 Assessment Boundaries

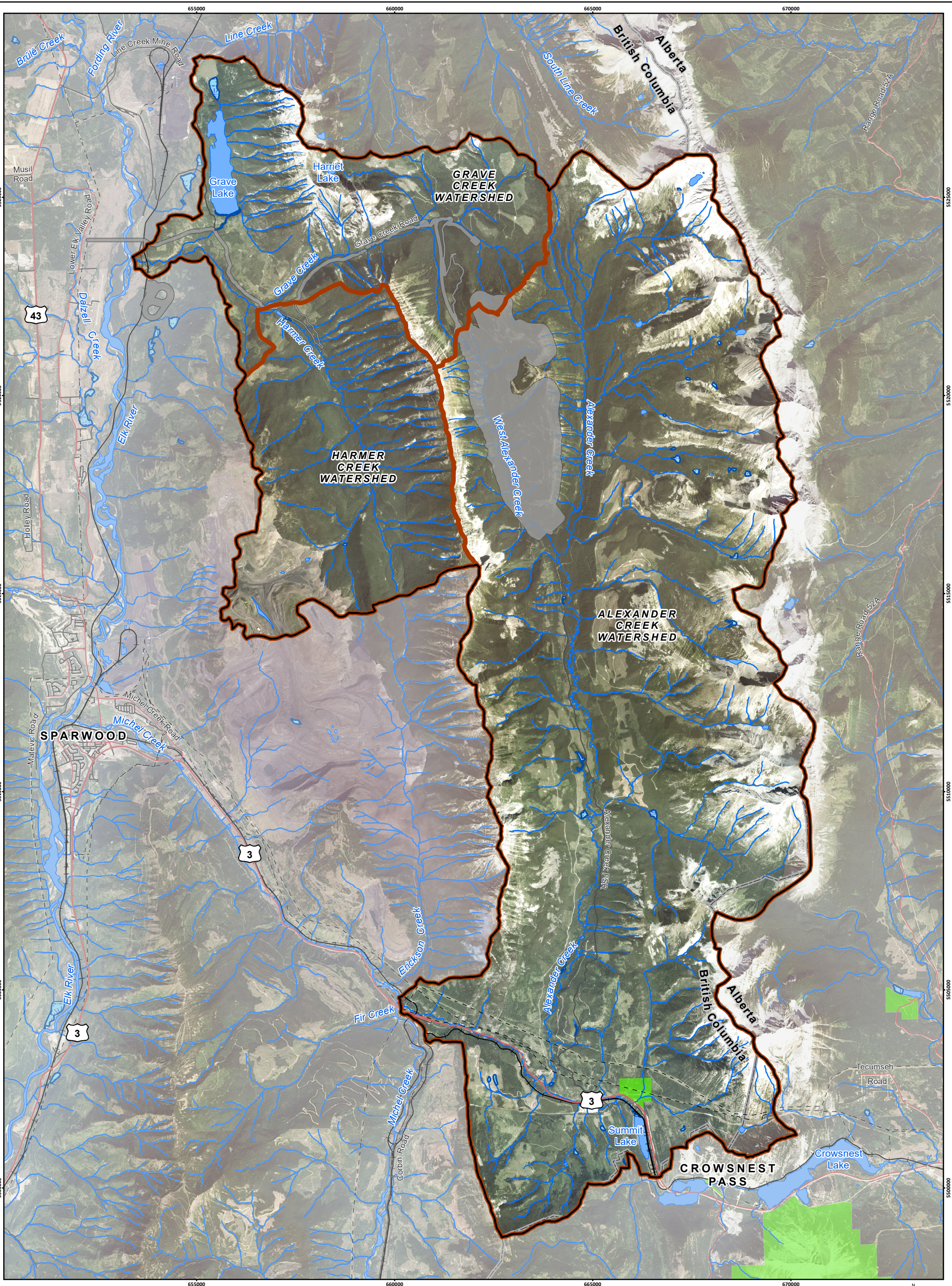
11.2.3.1 Spatial Boundaries

Three study areas were considered in the surface water quality assessment: the Project footprint, the Aquatic Local Study Area (LSA), and the Aquatic Regional Study Area (RSA). As detailed in Chapter 5, Table 5.3-2, the spatial boundaries for the surface water quality VC have changed from the study areas presented in the AIR. A discussion on the spatial boundaries used in the assessment is provided below.

The Project footprint encompasses the location of temporary and permanent works associated with the Project and covers approximately 1,283 hectares (ha) or approximately 13 square kilometres (km²; Figure 11.2-1). The centre of the Project is positioned approximately 12 km northeast of the District of Sparwood and approximately 5 km west of the provincial boundary between B.C. and Alberta. The Project footprint is defined as the area of physical disturbance associated with the Project and consists of the proposed surface extraction areas (three pits - North Pit, East Pit, and South Pit); Mine Rock Storage Facility; mine infrastructure and support facilities, including the plant area (raw coal stockpile area and processing plant); clean coal transportation route; rail loadout facility and rail siding; and ancillary facilities (i.e., water supply, power supply, natural gas supply, water, sewage treatment, fuel storage, and explosives storage). The Project footprint is located within portions of two watersheds, Grave Creek and Alexander Creek. The majority of the Project footprint is located within the Alexander Creek watershed, while the access roads leading to the mine are generally located within the Grave Creek watershed.

The Aquatic LSA includes the Project footprint and the surrounding area where potential impacts associated with Project activities could directly affect aquatic conditions. The Aquatic LSA covers an area of approximately 228.6 km² and extends to the catchment boundaries for the Grave Creek watershed (including Harmer Creek) and Alexander Creek watershed areas (including West Alexander Creek; Figure 11.2-1).

The Aquatic RSA generally encompasses the full extent of the Elk River watershed and the portion of Lake Koochanusa located north of the Canada-USA border (Figure 11.2-2). The Aquatic RSA extends beyond the Aquatic LSA and covers a total geographic area of approximately 4,387 km². The Aquatic RSA comprises the regional area in which the aquatic environment could potentially be directly or indirectly affected by the Project. The headwaters of the Elk River watershed originate within Elk Lakes Provincial Park and the River flows in a southerly direction to its outlet into Lake Koochanusa, approximately 20 km north of the Canada- U.S.A. border. Streamflows in the lower reaches of the Elk River are regulated by a hydroelectric dam near Elko (Elko Dam), which is operated by BC Hydro. The Aquatic RSA is the main study area for conducting the cumulative effects assessment on surface water quality.

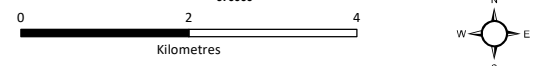


Crown Mountain Coking Coal Project

Figure 11.2-1
Aquatic Local Study Area (LSA)

LEGEND

- | | |
|--------------------------|---------------------------------|
| Aquatic Local Study Area | Waterbody |
| Watershed | Wetland |
| Project Footprint | Provincial Park/Protected Area |
| Highway | British Columbia/Alberta Border |
| Arterial/Collector Road | |
| Local/Resource Road | |
| Railway | |
| Transmission Line | |
| Watercourse | |

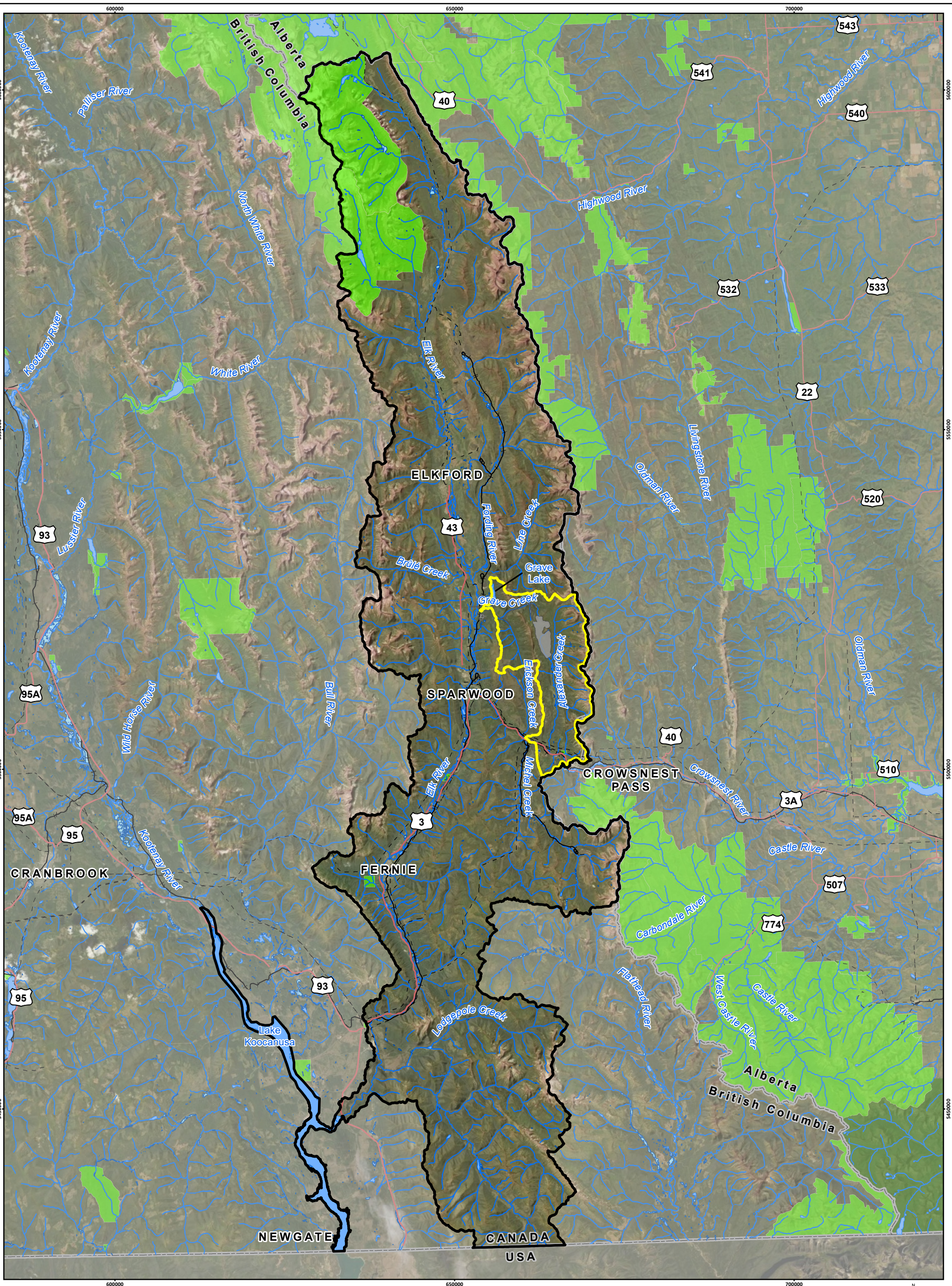


Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada. Imagery Provided By Landsat 8 (Aug 2018), and GeoBC Ortho Imagery (Aug 2016).

Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2021-02-25

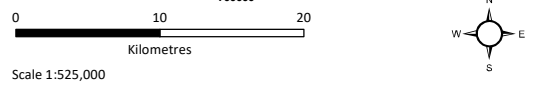


Crown Mountain Coking Coal Project

Figure 11.2-2
Aquatic Regional Study Area (RSA)

LEGEND

- Aquatic Regional Study Area
- Aquatic Local Study Area
- Project Footprint
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/ Alberta Border



Scale 1:525,000

Map Drawing Information:
Data Provided by NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeBC Open Data, Government of Alberta Open Data, Natural Resource Canada. Imagery Provided by ESRI.

Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2021-02-24

11.2.3.2 Temporal Boundaries

Temporal boundaries include the time periods during which the Project is anticipated to result in potential effects on VCs (EAO, 2013). The temporal boundaries considered in the assessment include the temporal limits of the Project in terms of its Construction and Pre-Production, Operations, Reclamation and Closure, and Post-Closure phases. The temporal boundaries of the Project used in the effects assessment include the timing of Project phases and activities as outlined in Table 11.2-2. Additional details on the Project phases and activities are provided in Chapter 3.

Table 11.2-2: Temporal Boundaries for the Project Effects Assessment

Phase	Project Year	Length of Phase (Years)
Construction and Pre-Production	1 – 2	2
Operations	3 – 17	15
Reclamation and Closure	18 – 19	2
Post-Closure	20 – 34	15

11.2.3.3 Administrative Boundaries

Administrative boundaries refer to the limitations imposed on the assessment by political, economic, or social constraints and consider the jurisdiction in which the Project is located. In addition to the applicable regulatory and policy framework as outlined in Table 11.1-1, the Project falls within the resource management area boundaries of Fisheries and Oceans Canada (DFO's) Pacific Region and the B.C. Ministry of Forests, Lands, Natural Resources Operations and Rural Development (FLNRORD) Rocky Mountain District in Kootenay Region 4.

As discussed in Section 11.1.1, the surface water quality assessment considers approved and working provincial water quality guidelines for freshwater aquatic life (B.C. WQGs), federal water quality guidelines for the protection of aquatic life (CWQGs; where B.C. guidelines do not exist), and regional long-term water quality targets from the Elk Valley Water Quality Plan (Teck, 2014). Where available, the B.C. WQGs for the protection of freshwater aquatic life were used as the preferred guideline for the assessment. WQGs for the protection of aquatic life are developed by the B.C. Ministry of Environment and Climate Change Strategy (ENV) following approved B.C. protocols and provide the basis for ambient water quality assessments to inform resource management decisions in B.C. (ENV, 2019c). Where B.C. WQGs do not exist, the CCME guidelines for the protection of freshwater aquatic life were applied, as were the EVWQP long-term water quality targets (where applicable). Parameters without established guidelines impose a limitation on the assessment due to lack of available policy statements. It is important to note that WQGs do not have any direct legal standing, and, on their own, are not considered to be legal standards.

Applicable federal and provincial guidelines are summarized in Table 11.2-3. The EVWQP long-term calcite index target of ≤ 0.50 in mine-exposed streams in the receiving environment which provide habitat to fish or directly provide other valued aquatic ecosystem components for fish (Teck, 2014) was also considered in the assessment of potential effects to surface water quality.

Table 11.2-3: Summary of Federal, Provincial, and Regional Water Quality Guidelines for the Protection of Freshwater Aquatic Life

Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	CCME Guideline for the Protection of Freshwater Aquatic Life (Short-term)	B.C. Water Quality Guidelines Working – Freshwater Aquatic Life	B.C. Water Quality Guidelines Approved Short-Term Maximum (Acute) – Freshwater Aquatic Life	B.C. Water Quality Guidelines Approved Long-Term Average (Chronic) – Freshwater Aquatic Life	Elk Valley Long-term Water Quality Targets (EVWQP) –MU4
Physical Tests						
Dissolved Oxygen (mg/L)	≥6.5 (cold water biota: other life stages); ≥9.5 (cold water biota: early life stages)					
pH	6.5 – 9.0					
Total Suspended Solids (TSS)	Dependent on background levels					
Turbidity (NTU)	Dependent on background levels					
Anions						
Chloride (Cl)	120 mg/L	640 mg/L		600 mg/L		
Fluoride (F)	0.12 mg/L		Variable	Variable ¹		
Sulphate (SO ₄)						429 mg/L
Nutrients						
Total Ammonia (NH ₃)	Variable		Variable	Variable		
Nitrate (as N)	3 mg/L			32.8 mg/L ¹		3 mg/L
Nitrite (as N)				Variable		
Phosphorous – Total (P)	0.004 mg/L			0.005 mg/L		

Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	CCME Guideline for the Protection of Freshwater Aquatic Life (Short-term)	B.C. Water Quality Guidelines Working – Freshwater Aquatic Life	B.C. Water Quality Guidelines Approved Short-Term Maximum (Acute) – Freshwater Aquatic Life	B.C. Water Quality Guidelines Approved Long-Term Average (Chronic) – Freshwater Aquatic Life	Elk Valley Long-term Water Quality Targets (EWWQP) –MU4
Organic / Inorganic Carbon						
Total Organic Carbon (TOC)	Dependent on background levels					
Dissolved Organic Carbon (DOC)	Dependent on background levels					
Total Metals						
Aluminum (Al)	100 µg/L ²			100 µg/L ^{2,3}		
Antimony (Sb)			9 µg/L			
Arsenic (As)	5 µg/L			5 µg/L		
Barium (Ba)			1,000 µg/L			
Beryllium (Be)			0.13 µg/L	0.13 µg/L		
Boron (B)	1,500 µg/L	29,000 µg/L		1,200 µg/L		
Cadmium (Cd)	Variable ⁵	Variable ⁸		Variable ¹		0.24 µg/L
Chromium (Cr)			8.9 µg/L ³			
Cobalt (Co)				110 µg/L	4 µg/L	
Copper (Cu)	Variable			Variable	Variable	
Iron (Fe)	300 µg/L		1,000 µg/L	1,000 µg/L		
Lead (Pb)	Variable ⁶			Variable ¹	Variable	
Lithium (Li)			870 µg/L		0.096 mg/L	
Manganese (Mn)				Variable ¹	Variable	
Mercury (Hg)	0.026 µg/L					
Molybdenum (Mo)	73 µg/L			2,000 µg/L	1,000 µg/L	

Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	CCME Guideline for the Protection of Freshwater Aquatic Life (Short-term)	B.C. Water Quality Guidelines Working – Freshwater Aquatic Life	B.C. Water Quality Guidelines Approved Short-Term Maximum (Acute) – Freshwater Aquatic Life	B.C. Water Quality Guidelines Approved Long-Term Average (Chronic) – Freshwater Aquatic Life	Elk Valley Long-term Water Quality Targets (EWWQP) –MU4
Nickel (Ni)	Variable ⁷		Variable ¹			
Potassium (K)			373,000 µg/L			
Selenium (Se)	1 µg/L			2 µg/L	2 µg/L	19 µg/L
Silver (Ag)	0.25 µg/L			Variable	Variable	
Thallium (Tl)	0.8 µg/L		0.8 µg/L ⁴			
Titanium (Ti)			2,000 µg/L			
Uranium (U)	15 µg/L	33 µg/L	8.5 µg/L			
Vanadium (V)						
Zinc (Zn)	Variable	Variable		Variable ¹	Variable	
Dissolved Metals						
Aluminum (Al)				pH dependent		
Iron (Fe)	300 µg/L			350 µg/L		

Notes:

mg/L denotes milligrams per litre

µg/L denotes micrograms per litre

NTU denotes nephelometric turbidity unit

¹ Guideline varies with hardness. Most conservative value listed.

² Short-term WQG – pH greater than or equal to 6.5. See formula for pH less than 6.5.

³ Guideline is for Chromium (III). Chromium (VI) guideline is 1 µg/L.

⁴ 30 day average guideline specific to the lower Columbia River.

⁵ Cadmium concentration of 0.04 µg/L is for waters of > 0 to < 17 mg/L hardness (as CaCO₃).

⁶ Lead concentration of 1 µg/L is for waters of 0 to < 60 mg/L hardness (as CaCO₃) or unknown hardness.

⁷ Nickel concentration of 25 µg/L is for waters of 0 to < 60 mg/L hardness (as CaCO₃) or unknown hardness.

⁸ The short-term cadmium concentration of 0.11 µg/L is for waters of 0 to < 5.3 mg/L hardness (as CaCO₃).

As discussed in Section 11.1.1, the proposed federal Coal Mining Effluent Regulations (CMER) will establish effluent quality standards for new and existing coal mines in Canada upon promulgation. The proposed limits for TSS, total nitrate, and total selenium are presented in Table 11.2-4. These limits are still considered draft and not yet in force and are presented solely for context.

Table 11.2-4: Proposed Coal Mining Effluent Regulation Limits for New and Existing Mines

Parameter	Unit	Existing Mines		New Mines	
		Maximum Monthly Mean Concentration	Maximum Grab Sample Concentration	Maximum Monthly Mean Concentration	Maximum Grab Sample Concentration
TSS	mg/L	≤ 50	≤ 100	≤ 35	≤ 70
Total Nitrate	mg/L, as nitrogen	≤ 10	≤ 20	≤ 5	≤ 10
Total Selenium	µg/L	≤ 10	≤ 20	≤ 10	≤ 20

Source: ECCC (2022)

The Montana Department of Environmental Quality, with approval of the U.S. Environmental Protection Agency in 2021, has established site-specific selenium standards for Lake Koocanusa and the Kootenai River (Montana Department of Environmental Quality, 2022). The water column standards for total dissolved selenium are 3.1 µg/L for the mainstem of the Kootenai River and 0.8 µg/L for Lake Koocanusa. These limits apply to the portion of Lake Koocanusa in the U.S.A. outside of Canada and are presented solely for regional context.

11.2.3.4 Technical Boundaries

Technical boundaries represent constraints imposed on the assessment due to limitations in the ability to predict the effects of the Project (EAO, 2013). Technical boundaries for the assessment of potential effects to surface water quality include:

- Limitations imposed by the constraints of the surface water quality and geochemistry baseline data collection, data coverage, and lack of historically available water quality and flow data for Alexander Creek and Michel Creek;
- Assumptions required in the predictive models, specifically the water and load balance model;
- Limitations imposed by the integration of the water and load balance model and the Elk Valley Regional Water Quality Model; and
- Lack of publicly available information on the predicted effluent concentrations or discharge limits for other reasonably foreseeable projects in the Aquatic RSA.

11.3 Regional and Local Overview

Within the Aquatic LSA and Aquatic RSA, current land uses include residential; recreational (e.g., hunting, ATV trails, fishing, hiking, etc.); exploration; resource; industrial; rangeland; agriculture; and forestry. Mining in the East Kootenay region has been ongoing for well over a century, with coal being the dominant resource extracted in the area.

Historical and current mining activities in the Elk Valley have resulted in elevated concentrations of selenium, nitrate, sulphate, and cadmium in local watercourses, as well as calcite formation in some watercourses (Teck, 2014). Other sources of water quality impacts include local municipalities, agriculture, forestry, and deposition from natural and anthropogenic air emissions.

11.3.1.1 Regional Environmental

The Aquatic RSA for the Project is situated over the dividing line of Upper Kootenay Basin and the Central Kootenay Basin hydrologic zones (Zone Numbers 19 and 20, respectively). This area is characterized by low precipitation and dry summers, cold and dry winters, and low-to-moderate snowpack (Columbia Basin Trust, 2017). As noted in Section 11.2.3.1, the Aquatic RSA is comprised of the full extents of the Elk River watershed and extends downstream to include the portion of Lake Koocanusa located north of the Canada-U.S.A. border. The Elk River watershed covers an area of approximately 4,381 km² and is generally oriented in a north to south direction. The Elk River has many significant tributaries, including the Fording River, Line Creek, Wigwam River, and Michel Creek (Figure 11.2-2). As shown in Figure 11.2-2, the eastern extent of the Aquatic RSA generally follows the B.C./Alberta border along the Continental Divide from the headwaters of the Elk River to southeast of Fernie. From southeast of Fernie to the Canada-U.S.A. border, the Aquatic RSA follows the boundary of the Elk River watershed, which is separated from the Alberta border by the Flathead River watershed.

11.3.1.2 Local Environment

The Project is situated in an area of steep topography of the Front Ranges Rocky Mountains of B.C. The relief on the Project property generally ranges from 1,850 to 2,200 metres above sea level (m asl). The area is characterized by rugged ridges with moderate to steep-sloping sides at higher elevations and gentle slopes at lower elevations. The west side of the Project is characterized by steep sided ridges and subdued mountains, while those on the east are rugged with many cirques and U-shaped valleys. The setting is truly mountainous, underlain mostly by structurally deformed sandstone, siltstone, mudstone, and coal.

Key watercourses in the Aquatic LSA include the Elk River, Michel Creek, Alexander Creek, West Alexander Creek, Harmer Creek, and Grave Creek (Figure 11.2-1). Waterbodies in, or in the immediate vicinity of, the Aquatic LSA include Grave Lake, Harriet Lake, Mite Lake, and Barren Lake. The Alexander Creek watershed is the largest drainage basin in the Aquatic LSA and covers a watershed area of approximately 184.9 km², which is oriented in a north to south direction. Alexander Creek flows in a southerly direction from its headwaters to its confluence with Michel Creek, approximately 10.7 km southeast of Sparwood. Michel Creek flows north-westerly along Highway 3 and ultimately discharges to the Elk River near Sparwood. The total length of Alexander Creek is approximately 25 km. Alexander Creek has numerous tributaries that generally consist of high-gradient mountain streams, with the most important tributary being West Alexander Creek.

The West Alexander Creek watershed covers an area of approximately 14.7 km² within the boundaries of the Alexander Creek watershed. West Alexander Creek flows in a south to southeast direction over a distance of approximately 6 km to its confluence with Alexander Creek. The watercourse has several tributaries that generally consist of small, high-gradient mountain streams.

The Grave Creek watershed covers an area of approximately 80.9 km² and is oriented in an east to west direction (Figure 11.2-1). Grave Creek generally flows westerly and drains into the Elk River, approximately 12.5 km north of Sparwood. Several tributaries drain into Grave Creek, the largest of which being Harmer Creek. The Harmer Creek watershed covers an area of approximately 39 km² within the boundaries of the Grave Creek watershed. Harmer Creek generally flows northerly and drains into Grave Creek approximately 12 km northeast of Sparwood.

11.4 Existing Conditions

This section describes the existing conditions in the Project footprint, Aquatic LSA, and Aquatic RSA in sufficient detail to enable potential effects of the Project on surface water quality to be identified, understood, and assessed.

11.4.1 Existing Regional and Local Information

Existing local and regional surface water quality data were compiled by conducting a desktop assessment of background information on regional water quality data in the Project footprint, the Aquatic LSA, and the Aquatic RSA. Data sources included:

- Environment and Climate Change Canada (ECCC) water quality monitoring station data;
- Provincial databases and mapping sites (e.g., B.C. Water Resources Atlas);
- Scientific research from local non-governmental organizations (NGOs);
- Technical studies; and
- Other environmental assessments (EAs) undertaken near the Project.

11.4.1.1 Regional Information

11.4.1.1.1 Regional Surface Water Quality

Surface water quality results were obtained from two ECCC water quality monitoring stations: BC08NK0004 Elk River south of Sparwood, located approximately 19 km southwest of the Aquatic LSA, and BC08NK0003 Elk River at Highway 93 near Elko, located approximately 75 km southwest of the Aquatic LSA. Basic summary statistics for the last 10 years of data at these two stations from February 2009 to 2019, including minimum, maximum, median, mean, standard deviation, and standard error, and 95% Upper Confidence Limits (UCLs) for select parameters, are provided in the Surface Water Quality Baseline Report in Appendix 11-B.

Golder Associates conducted a surface water quality baseline program in the vicinity of Teck's Elkview Operations in 2013 and 2014. Median and maximum concentrations of constituents were generally below the B.C. WQG for the reference sites (i.e., upper Harmer Creek, Grave Creek upstream of Harmer Creek, and Alexander Creek), with the exception of pH and maximum concentrations for total phosphorus, total chromium, total iron, total selenium, dissolved aluminium, phenanthrene, and pyrene (Golder Associates, 2015). The mainstem sites generally exceeded the B.C. WQG for median total selenium, while median concentrations of all other parameters were below the B.C. WQG. Maximum concentrations of nitrate, dissolved aluminium, pH, and all metals except total barium, total nickel, total manganese, total thallium, total uranium, and dissolved cadmium exceeded the B.C. WQG in surface water samples collected from at least one site (Golder Associates, 2015).

In general, the tributary sites had the most exceedances of the B.C. WQG, where median concentrations in at least one tributary site showed exceedances of total selenium, sulphate, nitrate, total phosphorus, total chromium, and pyrene (Golder Associates, 2015). Further exceedances of the B.C. WQG maximum concentrations included ammonia, chloride, nitrite, all total metals, dissolved aluminium, dissolved cadmium, dissolved iron, polycyclic aromatic hydrocarbons (PAHs), and pH values. Exceedances of total metals were largely attributed to high total suspended solids in the water samples.

The *Aquatic Environment Synthesis Report* (Windward et al., 2014) summarizes monitoring studies completed by Teck from 2011 to 2013 at 93 sampling stations. Nitrate, selenium, and sulphate were identified as primary parameters of concern within the Elk River watershed and the portion of Lake Koocanusa in B.C. Overall, nitrate, selenium, and sulphate showed an increasing trend at most mainstem stations and were identified above the site-specific benchmark in greater than 10% of mainstem (mine-affected) samples. Other parameters with at least one sample with a concentration above B.C. WQG or EVWQP targets included nitrite, ammonia, aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, uranium, vanadium, zinc, benzo(a)pyrene, phenanthrene, and pyrene. Elevated selenium concentrations were observed in Lake Koocanusa, but only exceeded the B.C. WQG of 2 µg/L in two samples. Within the Elk River downstream of mine operations, concentrations were below benchmark values for nitrate, selenium, and sulphate in the samples tested. Concentrations of these constituents were also found to decrease with increasing distance downstream from mining activities. Other parameters which were found to occasionally (<10% of samples) exceed the B.C. WQG or site-specific target values in some mine-affected tributary streams included nitrite, ammonia, aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, uranium, vanadium, zinc, benzo(a)pyrene, phenanthrene, and pyrene (Windward et al., 2014).

11.4.1.1.2 Active Coal Mining Operations in the Aquatic Regional Study Area

There are a number of existing active coal operations within the Aquatic RSA, including Teck's Fording River, Greenhills, Line Creek, and Elkview Operations. Discharges from these operations are authorized under Permit 107517 under the provisions of the *Environmental Management Act* (2003). The permit includes specific authorized discharge limits at established compliance points for each operation, with compliance points corresponding to locations where all or most of the point and non-point discharges from each mine site or portions of a mine site are expected to accumulate. These accumulated discharges are subject to various limits as outlined in the Permit, including monthly average and daily maximum concentrations for selenium, sulphate, and nitrate as summarized in Table 11.4-1 and Table 11.4-2.

Table 11.4-1: Summary of Monthly Average Concentration Limits For Selenium, Nitrate, and Sulphate at Compliance Points for Current Teck Coal Mining Operations (ENV, 2020b)

Location	Parameter	Monthly Average Timeframe		
		Effective November 19, 2014	Effective December 31, 2019	Effective December 31, 2023
Fording River Operations – Fording River Compliance Point FR FRCP1	Total selenium (µg/L)	130	90	61
	Nitrate as N (mg/L)	27	19	13
	Sulphate (mg/L)	580	620	650
Greenhills Operations – Fording River Compliance Point GH FR1	Total selenium (µg/L)	80	63	57
	Nitrate as N (mg/L)	20	14	11
Location	Parameter	Effective November 19, 2014	Effective December 31, 2015	Effective December 31, 2033
Line Creek Operations – Line Creek Compliance Point LC LCDSSLCC	Total selenium (µg/L)	80	50	29
	Nitrate as N (mg/L)	14	7	3
Location	Parameter	Effective November 19, 2014	Effective December 31, 2017	Effective December 31, 2021
Elkview Operations – Harmer Creek Compliance Point EV HC1	Total selenium (µg/L)	45	57	57
	Nitrate as N (mg/L)	4	16	8
	Sulphate (mg/L)	300	380	450
Location	Parameter	Effective Immediately	Effective December 31, 2021	Effective December 31, 2025
Elkview Operations – Michel Creek Compliance Point EV MC2	Total selenium (µg/L)	28	20	19
	Nitrate as N (mg/L)	6	6	6
Location	Parameter	Effective Immediately	-	-
Coal Mountain Operations – Michel Creek Compliance Point CM MC2	Total selenium (µg/L)	19	-	-
	Nitrate as N (mg/L)	5	-	-
	Sulphate (mg/L)	500	-	-

Table 11.4-2: Summary of Daily Maximum Concentration Limits for Selenium and Nitrate at Compliance Points for Current Teck Coal Operations (ENV, 2020b)

Location	Parameter	Daily Maximum Timeframe		
		Effective November 19, 2014	Effective December 31, 2019	Effective December 31, 2023
Fording River Operations – Fording River Compliance Point FR FRCP1	Total selenium (µg/L)	155	106	71
	Nitrate as N (mg/L)	32.5	23	15
Greenhills Operations – Fording River Compliance Point GH FR1	Total selenium (µg/L)	100	78	62
	Nitrate as N (mg/L)	29	17	15
Location	Parameter	Effective November 19, 2014	Effective December 31, 2015	Effective December 31, 2033
Line Creek Operations – Line Creek Compliance Point LC LCDSSLCC	Total selenium (µg/L)	95	58	33
	Nitrate as N (mg/L)	20	9	4

Teck has implemented a variety of water treatment technologies at existing coal mining operations in the Elk Valley since 2018 while working toward achieving the objectives of the Elk Valley Water Quality Plan (Teck, 2014). Additional treatment facilities are currently under construction or are planned to be completed by 2031. Current treatment strategies include saturated rock fill facilities and tank-based biological active water treatment plants, in addition to clean water diversions. The current permit limits for the West Line Creek Active Water Treatment Facility (operational since 2016 and re-commissioned in 2018) that discharges into Line Creek include a maximum concentration of selenium in effluent of 20 µg/L (monthly average) and 3 mg/L nitrate (daily maximum; ENV, 2020b). The Saturated Rock Fill Facility at Elkview Operations has been operational since 2018. The proposed permit limits for the effluent discharge from the Phase 2 facility expansion (currently under construction) include 41 µg/L selenium (monthly average) and 8 mg/L nitrate (daily maximum; Teck, 2020a).

Teck conducts annual water quality monitoring in the Elk Valley as required under Permit 107517. In 2019, site performance objectives for selenium, nitrate, sulphate, and cadmium were met at all seven order stations under the EVWQP (Teck, 2020b). However, there were seasonal exceedances of the selenium, nitrate, and sulphate limits at the Fording River FR_FRCP1 compliance point, in addition to seasonal exceedances of the uranium long-term B.C.WQG at this location. Several nitrate and selenium non-compliances also occurred at the Line Creek Operations compliance point LC LCDSSLCC in 2019. There were no exceedances at the Coal Mountain Operations compliance point CM MC2, and no exceedances of the dissolved cadmium site performance objectives or compliance point limits at any order station. Overall compliance at order stations and compliance points in 2019 was 97.2% (Teck, 2020b).

11.4.1.2 Local Surface Water Quality

The Columbia Basin Water Quality Monitoring Project (CBWQ) was undertaken between 2015 and 2017 to establish a baseline and collect water quality information at Alexander Creek (McPherson et al., 2018).

Alexander Creek was selected as the monitoring site due the increasing anthropogenic and development pressures that surround it. The water quality monitoring was conducted at the NGALX03 monitoring station located at Alexander Creek near its confluence with Michel Creek. Water quality at the monitoring station was overall of good quality. Total phosphorous was the only parameter to exceed the B.C. WQG working and approved short-term guidelines for freshwater aquatic life and long-term and short-term CWQGs for freshwater aquatic life in the spring of 2015 and the spring of 2017 monitoring events.

11.4.1.3 Local and Regional Potable Surface Water Resources

Water license points of diversion for drinking water sources and springs in the Aquatic LSA and Aquatic RSA were obtained from iMapBC. Teck has one active point of diversion at Breaker Lake in the western portion of the Aquatic LSA with the purpose listed as “well drill/transport management”, though the potential for this source to be used for drinking water purposes is unknown. There are several points of diversion and springs in the Aquatic RSA, though many licenses are now abandoned, and none occur directly in the flow path of the portion of the Elk River watershed that has the potential to be affected by the Project. Information on potential potable groundwater resources is described in Chapter 9.

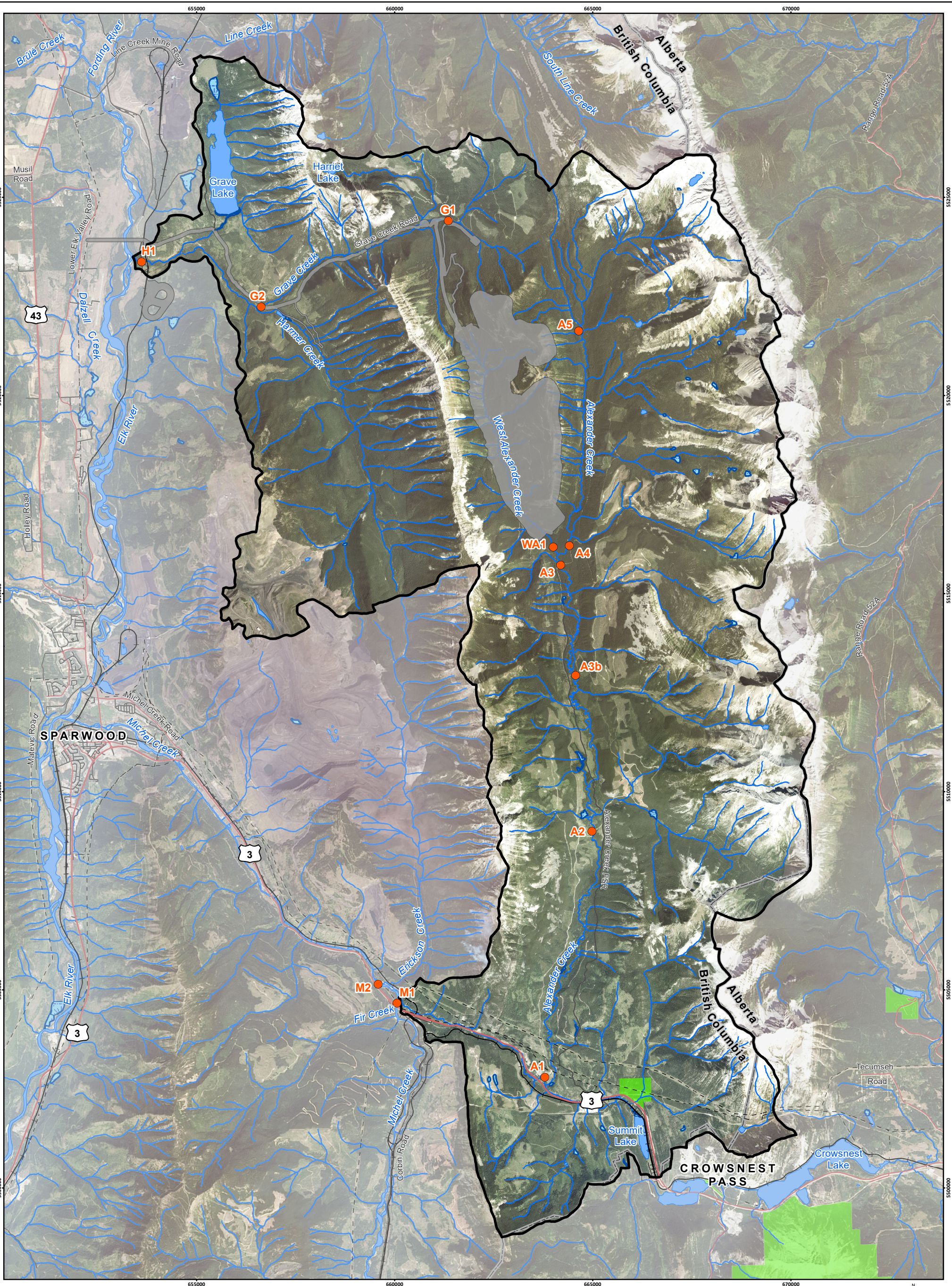
11.4.1.4 Transboundary Environment

Extensive water monitoring has been conducted in Lake Koochanusa to assess the impacts from the Elk River (Mebane et al., 2019). Mebane et al. (2019) estimated daily average selenium loads were similar at four mainstem sampling locations in the Kootenai River from Libby Dam (Lake Koochanusa) to the Idaho/B.C. border. The selenium loads in the Kootenai River ranged from approximately 12.1 to 14.5 kilograms per day (kg/d) in September 2018 (Mebane et al., 2019). In May 2019 during high flow sampling, estimated selenium loads were similar throughout the four mainstem Kootenai River sites, ranging from about 48.1 to 53.4 kg/d (Mebane et al., 2019). The results of the 2019 Koochanusa Reservoir Monitoring Program showed that monthly average concentrations of the EVWQP Order constituents (i.e., dissolved cadmium, nitrate, and sulphate) were below respective B.C. WQG at permitted stations in the Canadian portion of the reservoir (Minnow Environmental Inc., 2020). Monthly average selenium concentrations were below the B.C. WQG in all months at all permitted stations, with the exception of the station at the mouth of the Elk River (RG_ELKMOUTH; Minnow Environmental Inc., 2020).

11.4.2 Baseline Program

11.4.2.1 Methods

Extensive historical surface water quality information is available for the larger Elk River watershed; therefore, a site-specific surface water quality sampling program was carried out only in the Aquatic LSA. The objective of the baseline study was to characterize existing water quality conditions to aid in assessing potential environmental and human health effects that may occur as a result of the Project. The program focused on watercourses that may be directly affected as a result of the Project and was initiated in May 2012 at 12 lotic stations in Alexander Creek, West Alexander Creek, Grave Creek, and Michel Creek (Figure 11.4-1). No samples were collected in Harmer Creek; however, water quality in Harmer Creek was accounted for by sampling Grave Creek both upstream and downstream of the confluence with Harmer Creek. Details on the 12 sampling stations in order of surface flow pathway from upstream to downstream are provided in Table 11.4-3.

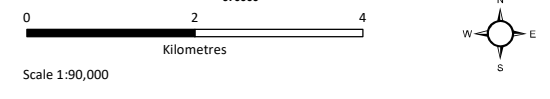


Crown Mountain Coking Coal Project

Figure 11.4-1
Surface Water Quality Sampling Stations

LEGEND

- Surface Water Quality Station
- Aquatic Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- - - Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- British Columbia/Alberta Border



Scale 1:90,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada. Imagery Provided By Landsat 8 (Aug 2018), and GeoBC Ortho Imagery (Aug 2016).

Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2021-02-24

Table 11.4-3: Location of Surface Water Quality Sampling Stations in Order of Surface Water Flow Path

Station	Watercourse	Easting	Northing	Rationale for Station Location
A5	Alexander Creek	664645.61	5521631.72	Upper reach of Alexander Creek. Reference site to assess background conditions of Alexander Creek. Located upstream of mining activities.
A4		664408.79	5516214.21	Lower reach of Alexander Creek, upstream of confluence with West Alexander Creek.
WA1	West Alexander Creek	664001.00	5516179.34	Upstream of confluence with Alexander Creek.
A3	Alexander Creek	664187.64	5515723.91	Downstream of confluence with West Alexander Creek.
A3(B)		664564.92	5512938.89	Downstream of confluence with West Alexander Creek. A3 was relocated approximately 200 m downstream and renamed to A3(B) in June 2014 due to extreme flooding and morphological changes to Alexander Creek.
A2		664975.82	5509004.95	Middle reach of Alexander Creek downstream of confluence with West Alexander Creek.
A1		663787.73	5502797.16	Lower reach of Alexander Creek.
M1		660056.45	5504669.21	Upstream of confluence with Alexander Creek.
M2	Michel Creek	659580.18	5505145.27	Downstream of confluence with Alexander Creek.
G1	Grave Creek	661350.70	5524412.42	Upper reach of Grave Creek. Reference site to assess background conditions of Grave Creek. Located upstream of mining activities.
G2		656628.18	5522243.04	Lower reach of Grave Creek upstream of confluence with Harmer Creek.
H1		653610.43	5523377.69	Near confluence of Grave Creek with the Elk River; downstream of rail tracks and confluence with Harmer Creek.

Note: Coordinates in NAD83 UTM Zone 11

Sampling was conducted on a monthly basis from May 2012 to 2015, with the addition of two intensive “5-in-30” (i.e., five samples in thirty days) high-flow (spring freshet) sampling periods completed in May/June 2014 and May/June 2015; and two intensive low-flow sampling periods completed in August/September 2014 and August/September 2015. Occasionally, some samples could not be collected at the desired frequency due to extreme flow velocities, lack of flow, frozen channel(s), or unsafe site access (e.g., winter avalanche risk). Sampling frequency was reduced to quarterly in late 2015 after approval from the B.C. Ministry of the Environment. No sampling was completed between mid-2016 to mid-2018 as the Project was on hold; quarterly sampling resumed in mid-2018 and is ongoing. In total, 58 sampling rounds between May 2012 and June 2019 were included in the baseline analysis, consisting of 623 normal samples and 70 blind field duplicate samples.

Specific methods, standards, and monitoring protocol used to collect baseline surface water quality data, including the sampling locations and analytical parameters, were conducted in accordance with the B.C. Ministry of the Environment's *Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia* (1998) and *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operations* (2016). Detailed methods are provided in Appendix 11-B.

Surface water was assessed in the field using a hand-held multi-meter to record real-time surface water quality measurements at the time of sample collection. Field-measured parameters include water temperature, pH, conductivity, specific conductance, dissolved oxygen (DO), turbidity, and oxidation-reduction potential (redox). In addition, surface water samples collected from each of the 12 sampling stations were analyzed by a certified analytical laboratory for the following parameters:

- Physical parameters (general chemistry);
- Anions and nutrients;
- Total and dissolved organic carbon;
- Total and dissolved metals; and
- Polycyclic aromatic hydrocarbons (PAHs).

Surface water quality results were compared to the CCME CWQG and the B.C. WQG, in addition to site-specific targets for selenium outlined in the EVWQP long-term water quality targets (Teck, 2014). The remaining three Order constituents (i.e., nitrate, sulphate, and cadmium) listed in the EVWQP follow guideline targets in line with the B.C. WQG and CWQG. Results were compared to both short-term and long-term B.C. WQG (approved and working). The B.C. WQG provide short-term maximum "acute" and long-term "chronic" comparison values. Short-term guidelines are intended to protect aquatic organisms against severe effects such as lethality due to short-term intermittent or transient exposures to contaminants (e.g., spill events; infrequent releases of short-lived substances). Long-term B.C. WQG are intended to protect all forms of aquatic life from lethal and sub-lethal effects over long-term indefinite exposures. Federal and provincial guidelines are summarized in Table 11.2-3.

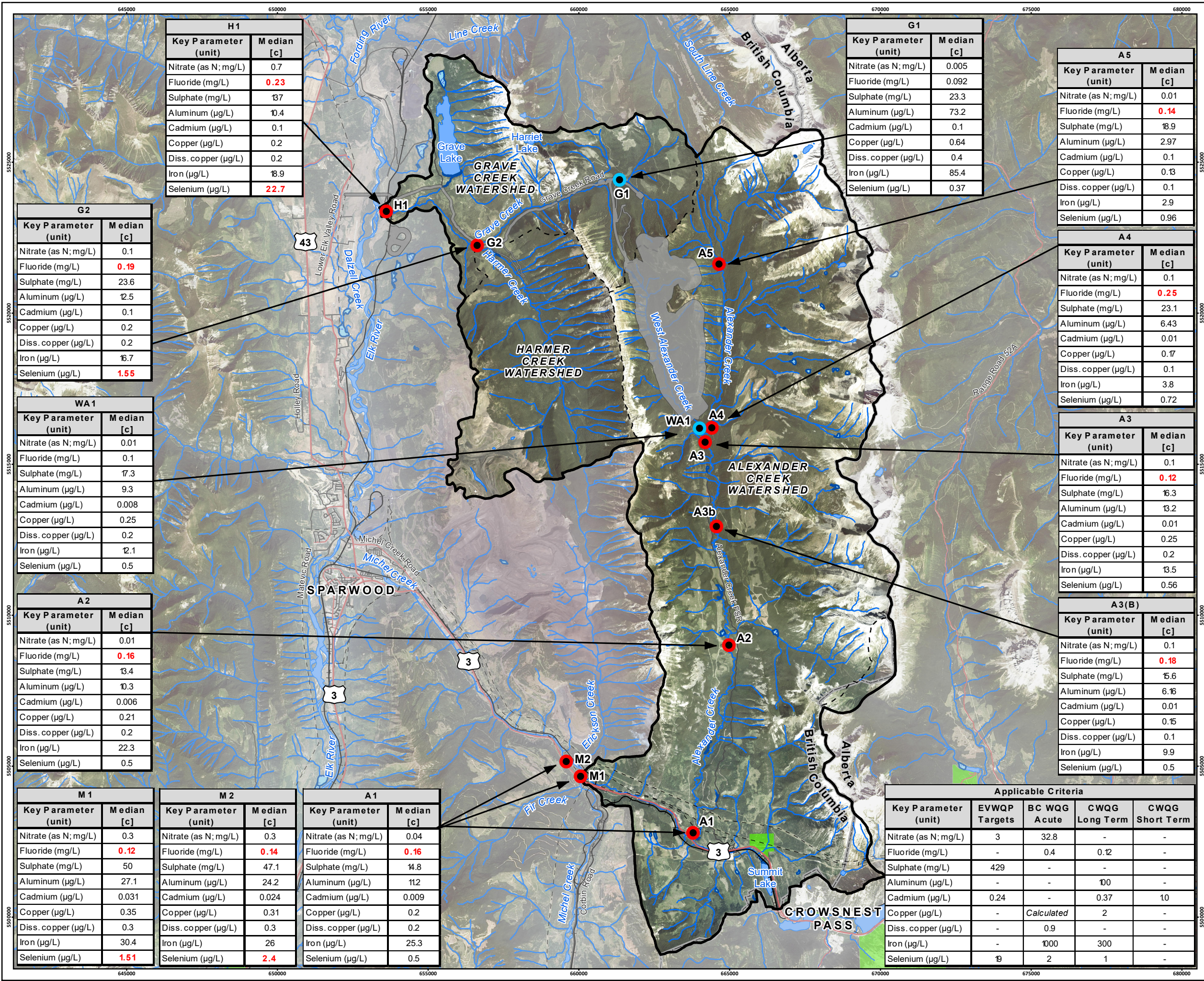
11.4.2.2 Results

Surface water analytical results from the baseline program between May 2012 and June 2019 were compared to the B.C. WQG working and approved short-term guidelines for freshwater aquatic life and long-term and short-term CWQGs for freshwater aquatic life. Exceedances of these guidelines are summarized in Table 11.4-4 and presented in Figure 11.4-2. Exceedances of the EVWQP target values are summarized in Table 11.4-5. Concentrations of PAH parameters tested for were below the B.C. WQG short-term and long-term and CWQG short-term and long-term across the Aquatic LSA. A summary of the field parameter results at each station is provided in Table 11.4-5. For more detail on the results of key parameters, including results of the 5-in-30 sampling events, refer to the Surface Water Quality Baseline Report in Appendix 11-B. Water quality trends in each watershed of the Aquatic LSA are described in the following subsections.

Generally speaking, analytical results are below laboratory reportable detection limits. Each of the laboratory reportable detection limits are below the respective guideline values.

Crown Mountain Coking Coal Project

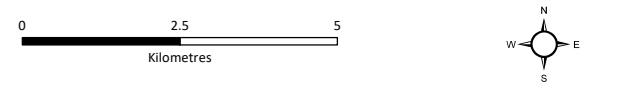
Figure 11.4-2
Overview of Surface Water Quality Key Parameters



LEGEND

- 0.16 Indicates median concentration exceeds one or more applicable criteria (EVWQP, BC WQG, CWQG)
- Surface Water Sampling Station
- Indicates median concentration for key parameters exceeds one or more applicable criteria
- Indicates median concentration for key parameters is below each of the applicable criteria
- Aquatic Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- - - Transmission Line
- Watercourse
- Waterbody
- Wetland
- Watershed
- Provincial Park/Protected Area
- British Columbia/Alberta Border

Notes:
 BC WQG - British Columbia Water Quality Guidelines
 CWQG - Canadian Water Quality Guidelines
 EVWQP - Elk Valley Water Quality Plan
 mg/L - milligrams per litre
 µg/L - micrograms per litre
 BC WQG Acute - Approved Short Term Max. (Acute) - Freshwater Aquatic Life
 CWQG Long Term - Aquatic Life Freshwater - Long Term
 CWQG Short Term - Aquatic Life Freshwater - Short Term
 Data are based on surface water analytical results reported in the Surface Water Quality Baseline Report (2020).
 Analytical results from 2012 to 2018; total fraction unless otherwise specified.
 Results from 2012 to 2016 are for dissolved sulphate, and results from 2018 to 2019 are for total sulphate.
 Where guideline values depend on results for other parameters, the most conservative value is listed.
 (-) indicates no comparison value available
 [c] - concentration
 Diss. - dissolved
 CWQG long term value for aluminum is based on a pH of >6.5.
 BC WQG Approved Short Term Max. (Acute) - Freshwater Aquatic Life for total copper is calculated using the BC Biotic Ligand Model (BLM).
 BC WQG Approved Long Term Average (Chronic) - Freshwater Aquatic Life guidelines apply only to 5-in-30 sampling events, and as such have been excluded.
 BC WQG Working - Fresh Water Aquatic Life; values do not exist for the key parameters, and as such have been excluded.



Scale 1:120,000
 Map Drawing Information:
 Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada.
 Imagery Provided By Landsat 8 (Aug 2018), and GeoBC Orthoimagery (Aug 2016).

Map Created By: RB
 Map Checked By: HEB
 Map Coordinate System: NAD 1983 UTM Zone 11N

Table 11.4-4: Summary of Exceedances of the B.C. WQG Short-Term and CWQG Short-Term and Long-Term

Sampling Station	Number of Sampling Events ¹	Parameter ²	B.C. WQG Short-Term Approved/Working ³	CWQG Long-Term ⁴	CWQG Short-Term ⁴	Median Concentration	Maximum Concentration ⁵
			(n=Number of Exceedances)	(n=Number of Exceedances)	(n=Number of Exceedances)		
A1	58	Fluoride	Variable	<u>0.12 mg/L (n=53)</u>	-	<u>0.16 mg/L</u>	<u>0.18 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=12)</u>	-	11.2 µg/L	<u>2,310 µg/L</u>
		Beryllium	0.13 µg/L (n=1)	-	-	0.01 µg/L	0.5 µg/L
		Cadmium	-	<u>Variable (n=1)</u>	<i>Variable</i>	0.009 µg/L	<u>0.862 µg/L</u>
		Copper	-	<u>Variable (n=1)</u>	-	0.21 µg/L	<u>10.3 µg/L</u>
		Copper (dissolved)	Variable (n=1)	-	-	0.16 µg/L	8.34 µg/L
		Iron	1,000 µg/L (n=1)	<u>300 µg/L (n=6)</u>	-	25.3 µg/L	<u>4,650 µg/L</u>
		Zinc	Variable (n=1)	-	-	0.82 µg/L	46.7 µg/L
A2	58	Ammonia	Variable	<u>Variable (n=1)</u>	-	0.012 mg/L	<u>0.43 mg/L</u>
		Fluoride	Variable	<u>0.12 mg/L (n=49)</u>	-	<u>0.16 mg/L</u>	<u>0.19 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=12)</u>	-	10.3 µg/L	<u>2,190 µg/L</u>
		Beryllium	0.13 µg/L (n=1)	-	-	0.01 µg/L	0.47 µg/L
		Cadmium	-	<u>Variable (n=1)</u>	<i>Variable</i>	0.006 µg/L	<u>0.714 µg/L</u>
		Copper	-	<u>Variable (n=2)</u>	-	0.21 µg/L	<u>8.39 µg/L</u>
		Iron	1,000 µg/L (n=1)	<u>300 µg/L (n=5)</u>	-	22.3 µg/L	<u>3,650 µg/L</u>
		Zinc	Variable (n=1)	-	-	0.64 µg/L	36.4 µg/L
A3	24	Ammonia	Variable	<u>Variable (n=1)</u>	-	0.011 mg/L	<u>0.39 mg/L</u>
		Fluoride	Variable	<u>0.12 mg/L (n=4)</u>	-	<u>0.12 mg/L</u>	<u>0.13 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=8)</u>	-	13.2 µg/L	<u>5,190 µg/L</u>
		Beryllium	0.13 µg/L (n=1)	-	-	0.01 µg/L	1.5 µg/L
		Cadmium	-	<u>Variable (n=1)</u>	<i>Variable (n=1)</i>	0.01 µg/L	<u>1.82 µg/L</u>
		Copper	-	<u>Variable (n=1)</u>	-	0.25 µg/L	<u>23.9 µg/L</u>
		Iron	1,000 µg/L (n=1)	<u>300 µg/L (n=5)</u>	-	13.5 µg/L	<u>9,720 µg/L</u>
		Manganese	Variable (n=1)	-	-	0.94 µg/L	1,350 µg/L
		Selenium	2 µg/L (n=1)	<u>1 µg/L (n=1)</u>	-	0.56 µg/L	<u>2.06 µg/L</u>
Zinc	Variable (n=1)	-	-	0.94 µg/L	93.8 µg/L		

Sampling Station	Number of Sampling Events ¹	Parameter ²	B.C. WQG Short-Term Approved/Working ³	CWOG Long-Term ⁴	CWOG Short-Term ⁴	Median Concentration	Maximum Concentration ⁵
			(n=Number of Exceedances)	(n=Number of Exceedances)	(n=Number of Exceedances)		
A3(B)	29	Fluoride	Variable	<u>0.12 mg/L (n=28)</u>	-	<u>0.18 mg/L</u>	<u>0.22 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=1)</u>	-	6.16 µg/L	<u>101 µg/L</u>
		Copper	-	<u>Variable (n=1)</u>	-	0.15 µg/L	<u>6.23 µg/L</u>
A4	58	Ammonia	Variable	<u>Variable (n=1)</u>	-	0.011 mg/L	<u>0.35 mg/L</u>
		Fluoride	Variable	<u>0.12 mg/L (n=50)</u>	-	<u>0.25 mg/L</u>	<u>0.357 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=2)</u>	-	6.43 µg/L	<u>2,910 µg/L</u>
		Beryllium	0.13 µg/L (n=1)	-	-	0.01 µg/L	0.57 µg/L
		Cadmium	-	<u>Variable (n=1)</u>	<i>Variable (n=1)</i>	0.01 µg/L	<u>1.29 µg/L</u>
		Copper	-	<u>Variable (n=1)</u>	-	0.17 µg/L	<u>13.1 µg/L</u>
		Iron	1,000 µg/L (n=1)	<u>300 µg/L (n=1)</u>	-	3.8 µg/L	<u>4,860 µg/L</u>
		Selenium	2 µg/L	<u>1 µg/L (n=4)</u>	-	0.72 µg/L	<u>1.06 µg/L</u>
		Zinc	Variable (n=1)	-	-	1.34 µg/L	73.8 µg/L
A5	57	Fluoride	Variable	<u>0.12 mg/L (n=37)</u>	-	<u>0.14 mg/L</u>	<u>0.187 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=1)</u>	-	2.97 µg/L	<u>226 µg/L</u>
		Copper	-	<u>Variable (n=1)</u>	-	0.13 µg/L	<u>3.21 µg/L</u>
		Selenium	2 µg/L	<u>1 µg/L (n=26)</u>	-	0.96 µg/L	<u>1.77 µg/L</u>
G1	57	Fluoride	Variable	<u>0.12 mg/L (n=5)</u>	-	0.092 mg/L	<u>0.22 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=21)</u>	-	73.2 µg/L	<u>837 µg/L</u>
		Copper	-	<u>Variable (n=1)</u>	-	0.64 µg/L	<u>4.6 µg/L</u>
		Iron	1,000 µg/L (n=2)	<u>300 µg/L (n=10)</u>	-	85.4 µg/L	<u>1,560 µg/L</u>
		Selenium	2 µg/L	<u>1 µg/L (n=4)</u>	-	0.37 µg/L	<u>1.84 µg/L</u>
G2	57	Ammonia	Variable	<u>Variable (n=1)</u>	-	0.013 mg/L	<u>0.97 mg/L</u>
		Fluoride	Variable	<u>0.12 mg/L (n=37)</u>	-	<u>0.19 mg/L</u>	<u>0.285 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=11)</u>	-	12.5 µg/L	<u>1,040 µg/L</u>
		Iron	1,000 µg/L (n=2)	<u>300 µg/L (n=6)</u>	-	16.7 µg/L	<u>1,390 µg/L</u>
		Selenium	2 µg/L (n=10)	<u>1 µg/L (n=39)</u>	-	<u>1.55 µg/L</u>	<u>2.67 µg/L</u>

Sampling Station	Number of Sampling Events ¹	Parameter ²	B.C. WQG Short-Term Approved/Working ³	CWOG Long-Term ⁴	CWOG Short-Term ⁴	Median Concentration	Maximum Concentration ⁵
			(n=Number of Exceedances)	(n=Number of Exceedances)	(n=Number of Exceedances)		
H1	57	Ammonia	Variable	<u>Variable (n=1)</u>	-	0.014 mg/L	<u>0.26 mg/L</u>
		Fluoride	Variable	<u>0.12 mg/L (n=57)</u>	-	<u>0.23 mg/L</u>	<u>0.279 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=9)</u>	-	10.4 µg/L	<u>407 µg/L</u>
		Iron	1,000 µg/L	<u>300 µg/L (n=4)</u>	-	18.9 µg/L	<u>902 µg/L</u>
		Selenium	2 µg/L (n=57)	<u>1 µg/L (n=57)</u>	-	<u>22.7 µg/L</u>	<u>29.8 µg/L</u>
M1	58	Ammonia	Variable	<u>Variable (n=1)</u>	-	0.018 mg/L	<u>0.4 mg/L</u>
		Fluoride	Variable	<u>0.12 mg/L (n=26)</u>	-	<u>0.12 mg/L</u>	<u>0.18 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=19)</u>	-	27.1 µg/L	<u>3,200 µg/L</u>
		Beryllium	0.13 µg/L (n=2)	-	-	0.01 µg/L	0.74 µg/L
		Cadmium	-	<u>Variable (n=2)</u>	<i>Variable (n=1)</i>	0.031 µg/L	<u>2.72 µg/L</u>
		Copper	-	<u>Variable (n=3)</u>	-	0.35 µg/L	<u>17 µg/L</u>
		Iron	1,000 µg/L (n=3)	<u>300 µg/L (n=10)</u>	-	30.4 µg/L	<u>6,310 µg/L</u>
		Selenium	2 µg/L (n=7)	<u>1 µg/L (n=46)</u>	-	<u>1.51 µg/L</u>	<u>3.29 µg/L</u>
M2	57	Fluoride	Variable	<u>0.12 mg/L (n=30)</u>	-	<u>0.14 mg/L</u>	<u>0.18 mg/L</u>
		Aluminum	-	<u>100 µg/L (n=17)</u>	-	24.2 µg/L	<u>2,200 µg/L</u>
		Aluminum (dissolved)	100 µg/L (n=1)	-	-	2.88 µg/L	358 µg/L
		Beryllium	0.13 µg/L (n=2)	-	-	0.01 µg/L	0.65 µg/L
		Cadmium	-	<u>Variable (n=2)</u>	<i>Variable (n=1)</i>	0.024 µg/L	<u>2.53 µg/L</u>
		Copper	-	<u>Variable (n=3)</u>	-	0.31 µg/L	<u>14.7 µg/L</u>
		Iron	1,000 µg/L (n=2)	<u>300 µg/L (n=8)</u>	-	26 µg/L	<u>4,580 µg/L</u>
		Selenium	2 µg/L (n=34)	<u>1 µg/L (n=45)</u>	-	<u>2.4 µg/L</u>	<u>10.6 µg/L</u>
		Silver	Variable (n=1)	<u>0.25 µg/L</u>	-	0.003 µg/L	0.108 µg/L
Zinc	Variable (n=1)	-	-	1.04 µg/L	61.1 µg/L		

Sampling Station	Number of Sampling Events ¹	Parameter ²	B.C. WQG Short-Term Approved/Working ³	CWQG Long-Term ⁴	CWQG Short-Term ⁴	Median Concentration	Maximum Concentration ⁵
			(n=Number of Exceedances)	(n=Number of Exceedances)	(n=Number of Exceedances)		
WA1	54	Fluoride	Variable	<u>0.12 mg/L (n=11)</u>	-	0.11 mg/L	0.131 mg/L
		Aluminum	-	<u>100 µg/L (n=13)</u>	-	9.3 µg/L	5,730 µg/L
		Barium	1,000 µg/L (n=1)	-	-	87 µg/L	1,070 µg/L
		Beryllium	0.13 µg/L (n=1)	-	-	0.01 µg/L	1.42 µg/L
		Cadmium	-	<u>Variable (n=1)</u>	<i>Variable (n=1)</i>	0.008 µg/L	<u>1.89 µg/L</u>
		Copper	-	<u>Variable (n=2)</u>	-	0.25 µg/L	<u>25.8 µg/L</u>
		Iron	1,000 µg/L (n=1)	<u>300 µg/L (n=6)</u>	-	12.1 µg/L	<u>11,800 µg/L</u>
		Manganese	Variable (n=1)	-	-	0.69 µg/L	<u>1,580 µg/L</u>
Zinc	Variable (n=1)	-	-	0.74 µg/L	101 µg/L		

Notes:

¹ Includes discrete 5-in-30 sampling events. Where parent and field duplicate samples were collected, it is considered a single event. If an exceedance was identified for only one of the parent and duplicate result, it has been considered an exceedance as a conservative measure.

² Refers to total fraction, unless otherwise specified.

³ B.C. WQG are for the protection of freshwater aquatic life, short-term.

⁴ CWQGs are for the protection of freshwater aquatic life, long-term and short-term, respectively.

⁵ Where the maximum value exceeds the respective B.C. WQG (approved /working) it is indicated in **BOLD**. Where the maximum value exceeds the respective CWQG long-term it is indicated by UNDERLINE. Where the maximum value exceeds the respective CWQG short-term it is indicated by *ITALICS*. Where the maximum value exceeds more than one comparison criteria, it is indicated by a combination these notations.

Table 11.4-5: Summary of Exceedances of the EVWQP Long-Term Water Quality Targets

Sampling Station	Number of Sampling Events ¹	Parameter ²	Number of Exceedances (n)	Elk Valley Long Term Water Quality Targets ³	Median Concentration ⁵	Maximum Concentration ⁵
A1	58	Nitrate	-	3 mg/L	0.04 mg/L	0.12 mg/L
		Sulphate ⁴	-	429 mg/L	14.8 mg/L	19.7 mg/L
		Cadmium	1	0.24 µg/L	0.009 µg/L	0.86 µg/L
		Selenium	-	19 µg/L	0.6 µg/L	0.96 µg/L
A2	58	Nitrate	-	3 mg/L	0.05 mg/L	0.128 mg/L
		Sulphate ⁴	-	429 mg/L	13.4 mg/L	23.3 mg/L
		Cadmium	1	0.24 µg/L	0.006	0.71 µg/L
		Selenium	-	19 µg/L	0.53 µg/L	0.67 µg/L
A3	24	Nitrate	-	3 mg/L	0.06 mg/L	0.246 mg/L
		Sulphate ⁴	-	429 mg/L	16.3 mg/L	21.4 mg/L
		Cadmium	1	0.24 µg/L	0.01 µg/L	1.82 µg/L
		Selenium	-	19 µg/L	0.6 µg/L	2.06 µg/L
A3(B)	29	Nitrate	-	3 mg/L	0.05 mg/L	0.091 mg/L
		Sulphate ⁴	-	429 mg/L	15.6 mg/L	19.9 mg/L
		Cadmium	-	0.24 µg/L	0.006 µg/L	0.016 µg/L
		Selenium	-	19 µg/L	0.5 µg/L	0.70 µg/L
A4	58	Nitrate	-	3 mg/L	0.09 mg/L	0.20 mg/L
		Sulphate ⁴	-	429 mg/L	23 mg/L	38.8 mg/L
		Cadmium	1	0.24 µg/L	0.01 µg/L	1.29 µg/L
		Selenium	-	19 µg/L	0.7 µg/L	1.06 µg/L
A5	57	Nitrate	-	3 mg/L	0.04 mg/L	0.11 mg/L
		Sulphate ⁴	-	429 mg/L	19 mg/L	30.3 mg/L
		Cadmium	1	0.24 µg/L	0.006 µg/L	0.29 µg/L
		Selenium	-	19 µg/L	1.0 µg/L	1.77 µg/L
G1	57	Nitrate	-	3 mg/L	0.01 mg/L	0.14 mg/L
		Sulphate ⁴	-	429 mg/L	23 mg/L	31 mg/L
		Cadmium	-	0.24 µg/L	0.02 µg/L	0.22 µg/L

Sampling Station	Number of Sampling Events ¹	Parameter ²	Number of Exceedances (n)	Elk Valley Long Term Water Quality Targets ³	Median Concentration ⁵	Maximum Concentration ⁵
		Selenium	-	19 µg/L	0.4 µg/L	1.84 µg/L
G2	57	Nitrate	-	3 mg/L	0.09 mg/L	0.219 mg/L
		Sulphate ⁴	-	429 mg/L	23.6 mg/L	34.4 mg/L
		Cadmium	-	0.24 µg/L	0.009 µg/L	0.22 µg/L
		Selenium	-	19 µg/L	1.6 µg/L	2.67 µg/L
H1	57	Nitrate	-	3 mg/L	0.7 mg/L	1.04 mg/L
		Sulphate ⁴	-	429 mg/L	137 mg/L	180 mg/L
		Cadmium	-	0.24 µg/L	0.02 µg/L	0.19 µg/L
		Selenium	40	19 µg/	22.7 µg/L	29.8 µg/L
M1	58	Nitrate	-	3 mg/L	0.3 mg/L	0.50 mg/L
		Sulphate ⁴	-	429 mg/L	49.3 mg/L	75.1 mg/L
		Cadmium	2	0.24 µg/L	0.03 µg/L	2.72 µg/L
		Selenium	-	19 µg/L	1.5 µg/L	3.29 µg/L
M2	57	Nitrate	-	3 mg/L	0.4 mg/L	1.14 mg/L
		Sulphate ⁴	-	429 mg/L	46.8 mg/L	99 mg/L
		Cadmium	2	0.24 µg/L	0.02 µg/L	2.53 µg/L
		Selenium	-	19 µg/L	2.4 µg/L	10.6 µg/L
WA1	54	Nitrate	-	3 mg/L	0.04 mg/L	0.14 mg/L
		Sulphate ⁴	-	429 mg/L	17.2 mg/L	21.5 mg/L
		Cadmium	1	0.24 µg/L	0.008 µg/L	1.89 µg/L
		Selenium	-	19 µg/L	0.5 µg/L	0.89 µg/L

Notes:

¹ Includes discrete 5-in-30 sampling events. Where parent and field duplicate samples were collected, it is considered a single event. If an exceedance was identified for only one of the parent and duplicate result, it has been considered an exceedance as a conservative measure.

² Refers to total fraction, unless otherwise specified.

³ Elk Valley Water Quality Target values appear as listed in Table S-1 of the EVWQP. Refer to the EVWQP for additional site-specific and guideline derivation information. Target values for Management Unit 4 are applicable to the Aquatic LSA.

⁴ Analytical results from 2012 to 2016 are for dissolved sulphate and results from 2018 to 2019 are for total sulphate.

⁵ Result values which exceeded the Target value are indicated in BOLD.

11.4.2.2.1 Alexander Creek and Michel Creek

The Alexander Creek watershed includes Alexander Creek and West Alexander Creek and drains into Michel Creek in the Michel Creek watershed (Figure 11.2-1). Overall, the results of the baseline study generally indicated low variability in concentrations at the sampling stations, with the exception of aluminum and iron. Fluoride, aluminum, dissolved copper, and iron concentrations did not show distinct spatial trends in the Alexander Creek watershed (Figure 11.4-2). Median selenium concentrations decreased and median iron concentrations increased from the headwaters of Alexander Creek downstream to Michel Creek (Figure 11.4-2; Table 11.4-4; Table 11.4-5).

Elevated concentrations of total aluminum were identified in surface water collected from each of the stations within the Alexander Creek watershed (i.e., stations A1, A2, A3, A4, and WA1) during a high-magnitude precipitation event in June 2013. Nine samples exceeded the guidelines for cadmium within the Alexander Creek watershed in June 2013 and May 2014. These elevated concentrations are associated with high flow volumes and significant precipitation events. The majority of copper exceedances also occurred within the Alexander Creek watershed during the high-precipitation June 2013 sampling event. Although pH, conductivity, redox, turbidity, and dissolved oxygen levels were within expected ranges for the region, water temperatures in West Alexander Creek (WA1) and Alexander Creek (A1 through A5) tended to be lower than those observed elsewhere in the LSA (Table 11.4-6).

Concentrations of key parameters (i.e., nitrate, fluoride, sulphate, aluminum, cadmium, copper, iron, and selenium) were consistently higher in Michel Creek compared to Alexander Creek (Figure 11.4-2; Table 11.4-4; Table 11.4-5). Michel Creek is larger than Alexander Creek and downstream of historic mining activities south of the highway at the M1 and M2 locations. Therefore, elevated concentrations of key parameters in these locations are likely attributable to increased sediment loadings associated with larger creek systems and high precipitation events and may also be influenced by historic mining activities upstream of these stations. Temperature, pH, conductivity, redox, turbidity, and dissolved oxygen were within typical ranges in Michel Creek.

11.4.2.2.2 Grave Creek and Harmer Creek

The Grave Creek Watershed includes Grave Creek and Harmer Creek. Fluoride, aluminum, copper, and iron concentrations did not show distinct spatial trends in the Grave Creek watershed (Figure 11.4-2). Concentrations of fluoride, aluminum, copper, and iron had low variability at the sampling stations in Grave Creek (Table 11.4-4). A distinct increase in selenium concentrations was consistently observed between stations G2 and H1 (Figure 11.4-2), as were increasing trends in fluoride, sulphate, and nitrate; however, nitrate and sulphate exceedances were not identified. Station H1 is situated in a known mine-affected reach of Grave Creek and elevated concentrations may be associated with mine impacts to Grave Creek. Temperature, pH, conductivity, redox, turbidity, and dissolved oxygen were within typical ranges in Grave Creek.

11.4.2.2.3 Elk Valley Water Quality Plan

The baseline program findings indicate that cadmium concentrations above the EVWQP target values were observed at sampling stations A1, A2, A3 and A4, M1, M2, and WA1 during a high-precipitation event in June 2013 (Table 11.4-5; Figure 11.4-1). With the exception of M1 and M2, each of these exceedances represents an isolated occurrence with respect to cadmium. Concentrations of cadmium in surface water

Table 11.4-6: Summary of Field Parameter Results

Sampling Station	Number of Sampling Events (n)	Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	Median	Minimum	Maximum
A1	56	Temperature (°C)	-	5.20	0.00	13.52
		pH	6.5 - 9.0	8.38	7.31	9.73
		Conductivity (µS/cm)	-	175.05	73.2	243.00
		Specific Conductance (µS/cm)	-	270.25	166.9	339.00
		Dissolved Oxygen (%)	-	89.20	68.8	131.00
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.18	8.34	14.39
		Redox (mV)	-	179.30	49.5	360.40
A2	56	Turbidity (NTU)	-	2.05	0.02	41.95
		Temperature (°C)	-	4.50	-0.10	12.25
		pH	6.5 - 9.0	8.33	7.13	9.63
		Conductivity (µS/cm)	-	166.25	100.7	263.00
		Specific Conductance (µS/cm)	-	252.70	165.2	315.40
		Dissolved Oxygen (%)	-	87.60	67.6	134.50
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.35	7.96	14.90
A3	54	Redox (Mv)	-	189.80	31.8	362.20
		Turbidity (NTU)	-	1.68	0.10	41.96
		Temperature (°C)	-	3.80	-0.10	10.62
		pH	6.5 - 9.0	8.34	7.13	9.30
		Conductivity (µS/cm)	-	150.00	100.7	205.00
		Specific Conductance (µS/cm)	-	227.90	165.2	314.00

Sampling Station	Number of Sampling Events (n)	Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	Median	Minimum	Maximum
		Dissolved Oxygen (%)	-	87.25	67.6	243.20
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.23	7.96	27.34
		Redox (Mv)	-	212.80	31.8	358.30
		Turbidity (NTU)	-	1.61	0.10	71.01
A3B	2	Temperature (°C)	-	2.35	1.50	3.20
		pH	6.5 - 9.0	8.25	8.37	8.39
		Conductivity (µS/cm)	-	230.00	161.1	230.00
		Specific Conductance (µS/cm)	-	282.20	282.2	282.20
		Dissolved Oxygen (%)	-	81.60	87.2	87.20
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	10.81	11.52	12.22
		Redox (Mv)	-	14.40	14.4	14.40
A4	55	Temperature (°C)	-	3.45	0.60	7.98
		pH	6.5 - 9.0	8.37	7.06	9.43
		Conductivity (µS/cm)	-	155.10	82.5	230.00
		Specific Conductance (µS/cm)	-	232.55	137.4	295.20
		Dissolved Oxygen (%)	-	88.00	76.0	121.60
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.58	8.96	13.90
		Redox (Mv)	-	194.80	14.6	354.70
Turbidity (NTU)	-	1.22	0.01	3.48		

Sampling Station	Number of Sampling Events (n)	Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	Median	Minimum	Maximum
A5	53	Temperature (°C)	-	2.31	0.00	5.70
		pH	6.5 - 9.0	8.20	6.74	8.96
		Conductivity (µS/cm)	-	134.00	59.9	194.00
		Specific Conductance (µS/cm)	-	219.25	123.9	264.70
		Dissolved Oxygen (%)	-	85.10	63.4	223.40
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.21	9.11	24.32
		Redox (Mv)	-	195.80	28.8	355.40
G1	55	Turbidity (NTU)	-	0.65	0.01	9.72
		Temperature (°C)	-	1.90	-0.10	9.69
		pH	6.5 - 9.0	8.25	7.14	8.68
		Conductivity (µS/cm)	-	162.00	77.2	213.00
		Specific Conductance (µS/cm)	-	266.00	127.8	332.90
		Dissolved Oxygen (%)	-	85.20	75.2	390.60
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.56	9.02	42.26
G2	55	Redox (Mv)	-	184.00	17.6	388.60
		Turbidity (NTU)	-	14.32	1.43	59.08
		Temperature (°C)	-	3.60	-0.10	8.10
		pH	6.5 - 9.0	8.38	7.26	8.96
		Conductivity (µS/cm)	-	192.00	102.0	342.00
G2	55	Specific Conductance (µS/cm)	-	285.50	155.8	626.00
		Dissolved Oxygen (%)	-	88.60	8.5	373.00

Sampling Station	Number of Sampling Events (n)	Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	Median	Minimum	Maximum
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.83	7.60	83.10
		Redox (Mv)	-	192.35	37.5	381.70
		Turbidity (NTU)	-	3.20	0.73	121.00
H1	55	Temperature (°C)	-	4.58	-0.20	10.60
		pH	6.5 - 9.0	8.50	7.41	8.96
		Conductivity (µS/cm)	-	329.35	181.5	411.00
		Specific Conductance (µS/cm)	-	489.30	194	679.00
		Dissolved Oxygen (%)	-	89.90	80.9	137.10
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.75	9.23	15.360
		Redox (Mv)	-	188.20	8.6	383.40
		Turbidity (NTU)	-	2.40	0.55	107.40
M1	55	Temperature (°C)	-	5.20	-0.10	15.20
		pH	6.5 - 9.0	8.36	7.5	9.04
		Conductivity (µS/cm)	-	214.00	70.2	305.90
		Specific Conductance (µS/cm)	-	315.00	117.6	509.50
		Dissolved Oxygen (%)	-	87.50	79.1	103.70
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.16	7.96	14.32
		Redox (Mv)	-	204.10	33.6	357.20
		Turbidity (NTU)	-	4.19	0.37	369.40

Sampling Station	Number of Sampling Events (n)	Parameter	CCME Guideline for the Protection of Freshwater Aquatic Life (Long-term)	Median	Minimum	Maximum
M2	54	Temperature (°C)	-	5.50	-0.10	13.60
		pH	6.5 - 9.0	8.41	7.73	9.99
		Conductivity (µS/cm)	-	223.70	90.1	292.00
		Specific Conductance (µS/cm)	-	318.20	135.2	502.00
		Dissolved Oxygen (%)	-	89.50	76.4	107.30
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.09	8.10	14.49
		Redox (Mv)	-	173.30	13.4	349.10
Turbidity (NTU)	-	2.95	0.39	289.90		
WA1	56	Temperature (°C)	-	3.45	0.00	9.83
		pH	6.5 - 9.0	8.33	7.37	9.40
		Conductivity (µS/cm)	-	154.75	69.9	208.70
		Specific Conductance (µS/cmC)	-	242.00	17.32	312.00
		Dissolved Oxygen (%)	-	86.40	66.3	199.50
		Dissolved Oxygen (mg/L)	6.5 - 9.5 ¹	11.42	8.93	22.16
		Redox (Mv)	-	188.30	35.5	354.90
Turbidity (NTU)	-	1.90	0.25	62.46		

Notes:

Bold values denote value exceeds CCME CWQG Long-term for pH.

¹ Lowest acceptable dissolved oxygen concentration for cold water biota: early life stages = 9.5 mg/L; other life stages = 6.5 mg/L

Units: °C = degrees Celsius; µS/cm = microsiemens/centimetre; mg/L = milligrams/litre; Mv = millivolts; NTU = nephelometric turbidity unit

collected from Stations M1 and M2 were also found to exceed the target during the May 2014 sampling event. Concentrations of cadmium from A5 were above the target in October 2012, and appear to be an isolated occurrence. Selenium concentrations in surface water were below the EVWQP long term target values for all sampling stations except at Station H1. Selenium concentrations in surface water collected from Station H1 were found to be above the target in 40 of 57 sampling events (Table 11.4-5; Figure 11.4-1). Concentrations of the other Order constituents (i.e., nitrate and sulphate) were below the EVWQP target values from 2012 to 2019 for the sampling stations within the Aquatic LSA (Table 11.4-5; Figure 11.4-1).

11.5 Project Effects Assessment

11.5.1 Thresholds for Determining Significance of Residual Effects

For the purpose of this assessment, thresholds for effects resulting from the Project that may result in changes to surface water quality include the approved or working B.C. water quality guidelines for the protection of freshwater aquatic life, the CCME guidelines for the protection of freshwater aquatic life (where B.C. guidelines do not exist), and the EVWQP long-term water quality targets (considered for downstream effects in the Elk River and Lake Koocanusa only; Teck, 2014). Where both short-term (acute) and long-term (chronic) guidelines exist, the long-term guidelines were used as the threshold values as a conservative measure. A summary of the relevant provincial, federal, and regional water quality guidelines is presented in Table 11.2-3 in Section 11.2.3.3.

The scope of the surface water quality effects assessment is restricted to parameters with approved or working provincial, federal, or regional guidelines for the protection of freshwater aquatic life. The assessment of residual effects on surface water quality focuses on water quality parameters that are predicted to increase in concentration above water quality guidelines as a result of the Project. It is important to note that exceeding a long-term water quality guideline does not imply that an unacceptable risk exists, but rather that the potential for adverse effects to aquatic life may be increased.

In consideration of the above, a significant adverse residual environmental effect on surface water quality is one where the Project degrades the physical and chemical characteristics of surface water to the extent that interaction with local surface water results in chemistry changes that may adversely affect aquatic life.

11.5.2 Project Effects

Project activities and components have the potential to result in adverse effects to surface water quality in both the immediate and downstream aquatic environments. This assessment focuses only on planned activities within the designed scope of the Project. Potential effects related to unplanned events (e.g., spills, equipment malfunctions, accidents) are presented in Chapter 21.

11.5.2.1 Project Interactions

Project activities during the Construction and Pre-Production, Operations, Reclamation and Closure, and Post-Closure phases have the potential to affect surface water quality. Key Project activities that are expected to interact with surface water quality, with a potential for adverse effects, are presented in

Table 11.5-1. Specific details on Project activities and components are discussed in Chapter 3. A spatial overview of the Project footprint infrastructure is shown in Figure 11.5-1.

Table 11.5-1: Project-Surface Water Quality Interaction Matrix and Ranking

Project Phase	Project Component	Description of Activities	Surface Water Quality	
Construction and Pre-Production	Transportation	Use of Highway 43, Line Creek Mine Road, Valley Road, and Grave Creek Road by highway transport trucks, light duty vehicles, and crew busses to transport personnel, materials, and consumable items	II	
	Logging of Merchantable Timber	Merchantable timber will be logged from the infrastructure and pre-production development footprint	II	
	Clearing and Grubbing	After the merchantable timber has been removed, the remaining vegetation will be cleared and grubbed from the infrastructure and pre-production development footprint	II	
	Stockpiling Wood Waste	Wood waste will be stockpiled on site and used for reclamation as a source of coarse woody debris	I	
	Quarry for Construction Materials	Excavation of roadbed materials from the North Pit footprint for use on Grave Creek Road	II	
	Water Management or Water Management Structures		Water management structures to support initial construction activities will be built prior to soil being salvaged from the run of mine (ROM) and plant site	II
			Interim Sediment Pond will be built prior to the soil removal and stockpiling from the pit access road and initial phase of the North Pit	II
			Grave Creek Reservoir will be constructed to act as a back-up source of process water	II
	Soil Salvage	Soil will be salvaged from the footprint of the infrastructure	II	
	Road Upgrading and Construction		Branch C Road will be widened and upgraded to facilitate construction and mine traffic to plant site area	II
			Grave Creek Road will be widened to facilitate the clean coal haul	II
			A new road will be constructed off the Valley Road to access the rail loadout for construction and operation	II
	Linear Infrastructure		Installation of the powerline	I
			Installation of the natural gas line	II
	Overland Conveyor		Clearing, grubbing, and construction of overland conveyor from the plant site to Grave Creek Road	II
Coal Handling Process Plant Construction		Excavating and pouring of foundation	II	
		Transportation of materials and personnel to site	I	

Project Phase	Project Component	Description of Activities	Surface Water Quality
		Constructing of the Coal Handling Process Plant (CHPP)	I
		Commissioning of the CHPP	I
	Workshop / Mine Dry Construction	Excavating and pouring of foundations	II
		Transportation of materials to site	I
		Construction of workshop / mine dry	I
		Equipment wash bay and heavy equipment parking	I
		Administration, first aid, and mine dry building	I
		Diesel tank farm	I
		Warehouse	I
		Potable water system	I
		Septic system	I
		Water supply pipelines from Grave Creek and West Alexander Creek	II
		Commissioning of the facilities	I
	Explosives Factory Construction	Construction of the explosives factory	I
	Rail Loadout Construction	Excavation and preparation of the rail bed	II
		Excavation and preparation of foundation stockpiling and coal handling systems	II
		Transportation of materials and personnel to site	I
		Construction of rail loadout	I
		Connection to the CP Fording Sub-line	I
	Labour	Commissioning of the rail loadout	I
Hiring of personnel for the mine, CHPP operations, administration, and coal haul		I	
	Training of personnel	I	
Construction Waste Materials	Collection and transfer to a recycling facility or other approved facility	I	
Operations	Transportation	Use of Highway 43, Line Creek Mine Road, Valley Road, and Grave Creek Road by highway transport trucks, light duty vehicles, and crew busses to transport personnel, materials, and consumable items	II
	Explosives Factory	Ammonium nitrate / emulsion storage facilities which have the ability to load explosive agents into delivery trucks	II
		Wash facility to decontaminate the bulk explosive delivery trucks	II
		Storage of explosives (detonators and boosters)	I
	Fuel Storage	Receiving bulk fuel deliveries	II

Project Phase	Project Component	Description of Activities	Surface Water Quality
		On-site storage of fuel	II
		Dispensing fuel	II
		Transferring fuel to on-site delivery trucks	II
	Mine Roads Development	Building roads from material sourced on-site	II
		Progressive clearing	II
		Removal of unconsolidated material	II
	Mining	Loading, hauling, and stockpiling of soil	III
		Drilling and loading of blastholes	II
		Detonating the explosives	II
		Loading, hauling, and dumping of mine rock	III
		Loading, hauling, and stockpiling of coal	II
	Site Water Requirements	Using contact water as the primary process make-up water from Interim Sediment Pond (Year 1 to 5)	I
		Using contact water as the primary process make-up water from the North Pit (Year 5 to 15)	I
		Backup reservoir in Grave Creek as a secondary source of process make-up water	I
	Coal Processing	Run of mine coal sizing	II
Washing coal		I	
Mechanical and thermal drying of coal		I	
Coal reject disposal (part of loading, hauling, and dumping of mine rock activities)		III	
Conveying clean coal		II	
Sewage Treatment	Sewage will be treated by a septic system constructed at the plant site which will support the administration, mine dry, and CHPP facilities	I	
Main Sediment Pond	Construction of Main Sediment Pond in Year 4	III	
	Management of the Main Sediment Pond discharge	III	
Reclamation	Reclaiming available areas as soon as possible to achieve reclamation objectives	II	

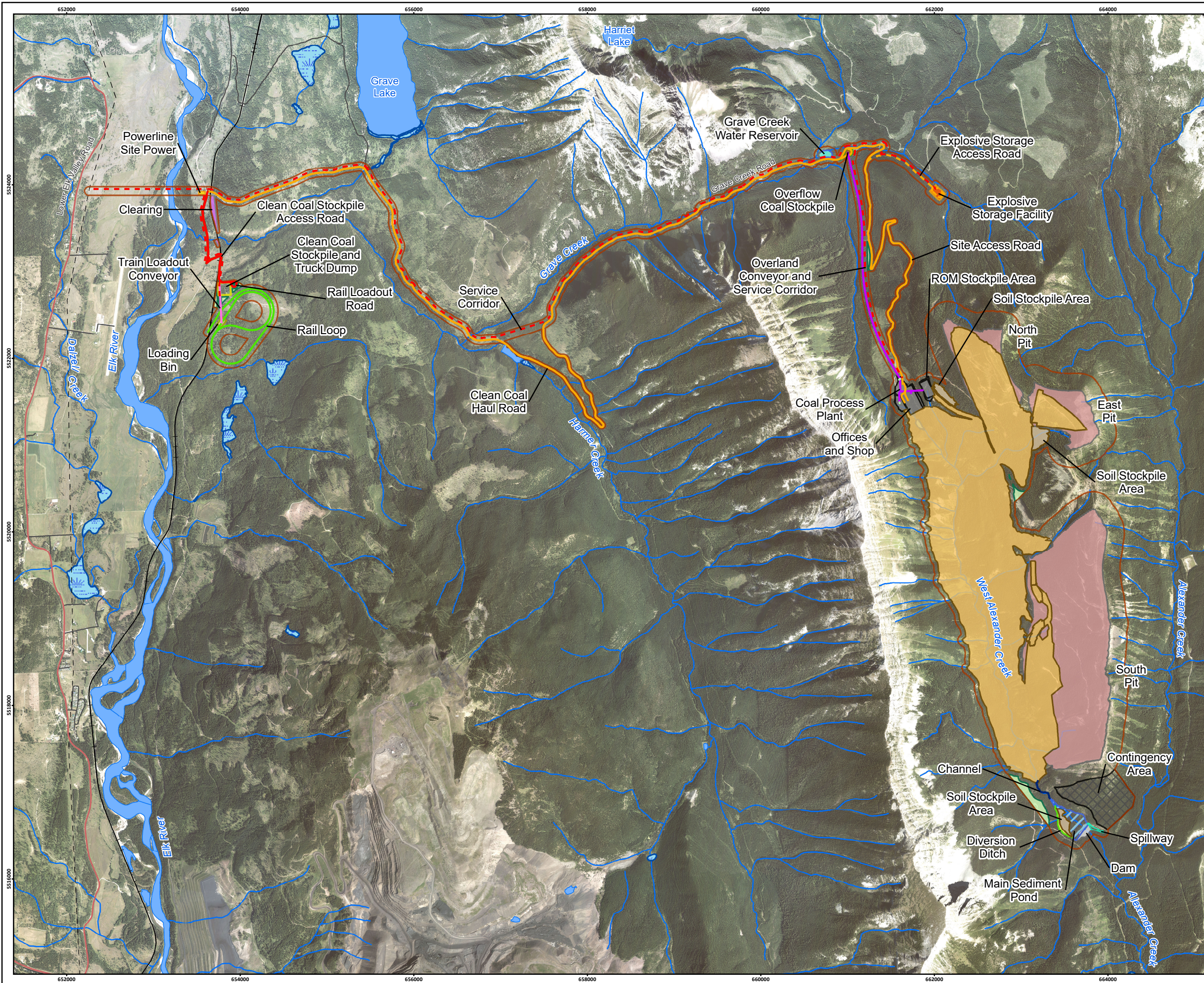
Project Phase	Project Component	Description of Activities	Surface Water Quality
Reclamation and Closure	Transportation	Use of Highway 43, Line Creek Mine Road, Valley Road, and Grave Creek Road by highway transport trucks, light duty vehicles, and crew busses to transport personnel, materials, and consumable items	II
	Dismantling Infrastructure and Buildings	Dismantling of the CHPP, maintenance facilities, administration, and other facilities	I
		Dismantling, salvaging, collecting, and transferring materials to a recycling facility or other approved facility	I
	Removal of Linear Infrastructure	Removal of the powerline	I
		Removal of the natural gas line	II
	Reclamation	Reclaiming available areas as soon as possible to achieve reclamation objectives	II
	Monitoring	Reclamation monitoring	I
		Geotechnical monitoring	I
		Aquatic effects monitoring	I
	Water Management	Management of the Main Sediment Pond discharge	III
Post-Closure	Water Management	Decommissioning the Main Sediment Pond once water quality objectives have been met	II
	Road Use	Branch C Road will remain as a permanent access road for future commercial and recreational use	I
	Rail Line	The rail line will remain as a permanent feature	I
		Reclamation monitoring	I
	Monitoring	Geotechnical monitoring	I
		Aquatic effects monitoring	I

Notes (after EAO, 2013):

I = No or negligible effect (positive or adverse) is anticipated; not carried forward in the assessment

II = Potential adverse effects requiring additional mitigation or substantive positive effects are expected; carried forward in the assessment

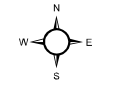
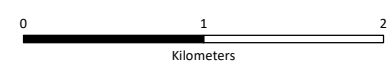
III = Key interaction resulting in potential significant adverse effect or significant concern; carried forward in the assessment



Crown Mountain Coking Coal Project

Figure 11.5-1
Project Footprint Infrastructure

LEGEND



Scale 1:42,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia
GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada.
Imagery Provided By GeoBC Orthoimagery (Aug 2016).

Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2021-02-24

In general, the Project has the potential to affect surface water quality through:

- Non-contact water runoff during site clearing, construction, soil movement/salvage, maintenance, and reclamation activities;
- Dust deposition from transportation, mining, and coal processing activities;
- Contact water runoff from mine disturbed areas and infrastructure (herein referred to as “mine site drainage”);
- Nitrogen loading from explosives use;
- Routine, small releases of hydrocarbons;
- Disposal of mine rock and coal rejects;
- Surface water-groundwater interactions; and
- Sediment pond discharge to the receiving environment.

Interactions were not identified for Project activities relating to:

- Stockpiling of wood waste for reclamation purposes, as natural wood waste does not have the potential to adversely affect surface water quality;
- Transportation, construction, and commissioning of prefabricated structures including the Coal Handling Process Plant, workshop, mine dry, explosives factory, and components of the rail loadout, as effects to surface runoff are anticipated to be minimal once foundations are excavated and poured;
- Hiring and training of personnel, as these activities do not have the potential to adversely affect surface water quality;
- Disposal of construction waste materials, as materials will be stored primarily in C cans or other secure containers prior to transport and disposal offsite;
- Storage of explosives (detonators and boosters), as these will be stored in secure facilities that meet all environmental, health and safety design requirements;
- Domestic sewage produced at the Project site will be treated via a septic system. Treated solids will be removed by a qualified contractor and disposed offsite at an approved facility, and treated effluent will be directed to a disposal field located adjacent to the mine office building and therefore will not have the potential for interaction with the aquatic receiving environment;
- Water withdrawal, as withdrawal of water from Grave Creek is expected to be minimal (reduction of flows will be between approximately 0.1% and 5.9% of base flows; see Chapter 10) and contact water will be the primary process make-up water; therefore, negligible potential effects on surface water quality in Grave Creek are assumed;
- Washing and drying of coal, as these activities will take place within the Coal Handling Process Plant and therefore do not have the potential to affect surface water quality through dust emissions or surface runoff. For the purposes of the surface water quality assessment, plant water is assumed to be 100% contained besides water lost as moisture in the coal rejects, during the clean coal drying process, and as moisture in clean coal product;
- Dismantling of the Project infrastructure, as removal of prefabricated structures are anticipated to have minimal effects to surface runoff; and
- Reclamation, geotechnical, and aquatic effects monitoring, as these activities do not have the potential to adversely affect surface water quality.

Potential effects on surface water quality as a result of the Project that are carried forward in the discussion of potential effects are summarized in Table 11.5-2.

Table 11.5-2: Potential Effects on Surface Water Quality

Potential Effect	Rationale for Selection of Environmental Effect
Change in Surface Water Quality from Non-Contact Water Runoff	Erosion and sedimentation during site clearing, construction, maintenance, and reclamation activities could result in elevated levels of TSS and turbidity in nearby watercourses.
Change in Surface Water Quality from Dust Deposition	Project activities such as on-site transportation of personnel, construction materials, and raw and clean coal; mine rock movement; blasting; and coal processing may generate dust, resulting in elevated TSS concentrations in nearby waterbodies through atmospheric deposition.
Change in Surface Water Quality from Mine Site Drainage	<p>Mine site drainage typically has elevated concentrations of TSS, turbidity, and potentially other substances (e.g., petroleum hydrocarbon products, coal dust) entrained from contact with mine disturbed areas and could result in changes to surface water quality in the receiving environment.</p> <p>The storage and transport of petroleum hydrocarbon products (e.g., gasoline, diesel, lubricants, hydraulic fluids, and solvents), as well as fueling and maintenance of machinery, heavy equipment, and vehicles, have the potential to release minor amounts of hydrocarbons from routine activities (e.g., vehicle refuelling) to local drainages and nearby watercourses.</p> <p>Open pit mining and mine development will require blasting, and fixed emulsion and ammonium nitrate (ANFO) will be stored on site. Trace residues from blasting contain nitrogen compounds that can remain on the surface, including on mine rock and excavated rock. As a result, mine site drainage released to the receiving environment may contain elevated levels of nitrogen compounds.</p> <p>During active mining of the pits, it will be necessary to dewater each pit through the use of drainage ditches, berms, sumps, and pumps. Mine dewater released to the receiving environment may contain elevated concentrations of suspended solids or other parameters such as metals and nutrients.</p>
Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects	Seepage and metal leaching/acid rock drainage (ML/ARD) from the Mine Rock Storage Facility may result in increased concentrations of selenium or other substances in the mine site drainage released to the receiving environment.
Change in Surface Water Quality from Surface Water – Groundwater Interactions	The Project area includes both gaining and losing reaches within Project area watercourses. Changes to groundwater quality via seepage from mine disturbed areas could result in potential changes to surface water quality.
Change in Surface Water Quality from Sediment Pond Discharge	Discharge from the sediment ponds has the potential to contain elevated concentrations of TSS, selenium, nitrate, and other parameters that will be released to the receiving environment. Sediment pond discharge may result in increased calcite formation and erosion downstream of the Project.

11.5.2.2 Discussion of Potential Effects

The potential effects identified in Table 11.5-2 are discussed in the context of each Project phase (Construction and Pre-Production, Operations, Reclamation and Closure, and Post-Closure) in the following subsections.

While potential changes to oxygen levels, water temperature, and ice regime in the receiving environment were considered, as required by the EIS Guidelines (Canadian Environmental Assessment Agency, 2015), no predictions were made for these parameters in the surface water quality effects assessment. These parameters are mainly influenced by regional climatic conditions (air temperature, snow melt, etc.) and are not expected to be substantially influenced by Project activities. A discussion on potential changes to dissolved oxygen levels in the context of fish habitat is included in Chapter 12.

11.5.2.2.1 Change in Surface Water Quality from Non-Contact Water Runoff

Erosion and sedimentation may occur during all phases of the Project, resulting in elevated levels of TSS and turbidity in waterbodies within, adjacent to, and downstream of the Project footprint. Where feasible, surface water diversions will be constructed to divert clean runoff from undisturbed areas north of the Grave Creek-West Alexander Creek drainage divide.

Construction and Pre-Production

During Construction and Pre-Production, some erosion and sedimentation is expected from land clearing activities including logging of merchantable timber and clearing and grubbing of the infrastructure and pre-production development footprint. Excavation of the quarry for construction materials and foundations for mine infrastructure, construction of the Interim Sediment Pond and Grave Creek Reservoir, and soil salvage may similarly result in the disturbance, transport, and relocation of surficial materials to the receiving environment.

During construction, the Branch C Road and Grave Creek Road will be upgraded, which will require clearing and grubbing of vegetation to allow for road widening, culvert installation, and bridge upgrades, all of which may result in excess sedimentation in nearby creeks. The use of heavy machinery within or adjacent creeks and associated drainage channels may lead to localized erosion, resulting in additional sedimentation to watercourses. A new road will also be constructed off the Valley Road to access the rail loadout.

Two temporary sediment ponds will be constructed to capture construction runoff water during the construction of the ROM pad and facilities pad, and construction of smaller, local water management structures (i.e., ditches and sumps will commence prior to mining begins in the North Pit. Discharge from the temporary sediment ponds will join a drainage ditch adjacent to the Lower Haul Road and discharge to the West Alexander Creek catchment.

Operations

During site operations, some localized erosion and sedimentation is expected from activities including:

- Mine road development;
- Construction of the Main Sediment Pond;
- Loading, hauling, and stockpiling of soil;

- Removal of unconsolidated materials from the pits; and
- Reclamation activities.

Where possible, non-contact water runoff will be directed away from the mine disturbed areas by means of small catchment sumps and drainage ditches and routed to the natural catchments draining watercourses. However, due to localized challenges such as geotechnical stability and avalanche risks, channel construction is not feasible in all areas of the site such as the upper western slopes of West Alexander Creek above the Mine Rock Storage Facility. As a result, it is expected that water management structures will intercept both surface runoff from undisturbed areas, as well as from mine disturbed areas at these locations.

Reclamation and Closure

During Reclamation and Closure, some localized erosion and sedimentation may occur from the decommissioning of mine site infrastructure and reclamation of remaining disturbed areas. The Main Sediment Pond and associated sediment control structures will remain in place until final closure of the site to management the potential movement of sediment into the receiving environment.

Post-Closure

No potential adverse effects to surface water quality from non-contact water runoff are anticipated during Post-Closure, as all activities with the potential to result in erosion and sedimentation to the receiving environment will be completed prior to mine closure.

11.5.2.2.2 Change in Surface Water Quality from Dust Deposition

Project activities such as site clearing, construction of facilities and infrastructure, construction and upgrading of access and haul roads, transportation of soil, raw coal, mine rock, and coal rejects, use of heavy equipment, and operation of vehicles have the potential to affect air quality (due to the generation of dust), and subsequently there is the potential to affect surface water quality through atmospheric deposition of particulate material. Potential effects to air quality resulting from Project activities, including particulate deposition, are discussed in detail in Chapter 6.

Dust deposition may occur during all phases of the Project, resulting in elevated levels of dustfall, or total particulate matter (TPM) in waterbodies within, adjacent to, and downstream of the Project footprint. Many of the activities conducted within the surface extraction areas, access and haul roads, rail loadout, and supporting infrastructure have the potential to generate dust, potentially resulting in elevated TSS within nearby waterbodies.

The results of the air quality assessment show that the dispersion of dust emissions from Project activities have the potential to affect watercourses within and adjacent to the Project footprint, where applicable air quality objectives for particulate matter may be exceeded greater than 1% of the time (see Chapter 6). Watercourses potentially affected by dust deposition may include Grave Creek along the haul road, Alexander Creek to the east and southeast of the pits and Mine Rock Storage Facility, Harmer Creek adjacent to the haul road, and the Elk River west of the rail loadout (Chapter 6, Figure 6.5-4).

Construction and Pre-Production

During the Construction and Pre-Production phase, dust is expected to be generated by:

- The transportation of personnel and materials;
- Land clearing activities;
- Road construction and upgrading;
- Excavation of the quarry for construction materials;
- Excavations for foundations; and
- Construction of water management infrastructure such as the Grave Creek Reservoir and Interim Sediment Pond.

Dust deposition generated by these activities could lead to increased TSS concentrations in the aquatic receiving environment.

Operations

During site operations, dust is expected to be generated by the following activities:

- Blasting;
- Transportation of personnel and materials;
- Loading, hauling, and dumping of mine rock and coal;
- Mine road construction;
- Run of mine coal sizing;
- Conveying clean coal; and
- Reclamation activities.

Dust deposition generated by these activities could lead to increased TSS concentrations in the aquatic receiving environment.

Reclamation and Closure

During Reclamation and Closure, some dust is expected to be generated through the decommissioning of mine site infrastructure and reclamation of remaining disturbed areas. Dust suppression will continue as required during reclamation activities.

Post-Closure

No potential adverse effects to surface water quality from dust deposition are anticipated Post-Closure, as all activities with the potential to result generate dust, with the exception of occasional light vehicle traffic related to maintenance and monitoring activities, will be completed during the Reclamation and Closure phase.

11.5.2.2.3 Change in Surface Water Quality from Mine Site Drainage

Activities associated with a change in surface water quality from mine site drainage are generally limited to the Operations phase, except as noted in the description of activities below.

Mine site drainage can have elevated concentrations of TSS, turbidity, and potentially other substances (e.g., explosives residues, petroleum hydrocarbon products, coal dust) as a result of contact with mine

disturbed areas and may result in changes to surface water quality in the receiving environment. Mine site drainage comprises runoff that comes into contact with mine disturbed areas and infrastructure, including access and haul roads, stockpile and transfer areas, mine pits, plant areas, and the Mine Rock Storage Facility. Although the mine site drainage includes water discharged from the Mine Rock Storage Facility, changes to surface water quality as a result of ML/ARD are discussed as a separate potential effect. This subsection focuses on potential changes to surface water quality as a result of blasting, release of hydrocarbons, and pit dewatering activities.

Localized erosion and sedimentation is anticipated to result in elevated levels of TSS and turbidity in mine site discharge throughout the Operations phase due to mining activities such as explosives detonation, and the loading, hauling, and dumping of soil, unconsolidated material, and mine rock. Runoff from mine disturbed areas will require retention in sediment ponds (e.g., passive sedimentation) prior to being discharged into the environment to comply with approval conditions for TSS, turbidity, and other parameters determined during the permitting process.

Nitrogen Loading from Explosives Use

The development of the North, South, and East Pits will require blasting, necessitating the storage of fixed emulsion and ammonium nitrate (ANFO) on site in a designated explosives factory. Explosives storage and handling and decontamination of bulk explosive delivery trucks at the explosives factory have the potential to result in elevated concentrations of nitrogenous compounds in mine site drainage. Loading of blastholes with explosives in the pits also has the potential to result in elevated concentrations of these compounds in the mine site drainage. Mine rock and excavated rock can also include blasting residues that contain trace nitrogen compounds that remain on the surface.

In general, ANFO consists of 94% ammonium nitrate (NH_4NO_3) and 6% fuel oil (Morin and Hutt, 2009). Blasting reactions often do not completely consume ANFO, which may result in residual nitrogen, depending on explosives handling and blasting efficiency. There is limited information on the prediction of nitrogenous compounds in mine site drainages resulting from blasting activities; however, Ferguson and Leask (1988) found that 0.2% of explosives remain as residues and are lost to runoff in dry conditions and between 2% and 5% in wetter conditions.

Blasting activities will be minimal during Construction and Pre-Production and will cease at the end of Operations, with no additional potential for nitrogen loading from blasting anticipated during Reclamation and Closure and Post-Closure phases of the Project.

Hydrocarbons

The storage and transport of petroleum hydrocarbon products (e.g., gasoline, diesel, lubricants, hydraulic fluids, and solvents), as well as fueling and maintenance of machinery, heavy equipment, and vehicles, have the potential to release small amounts of hydrocarbons to local drainages and nearby watercourses. Reportable spills as outlined in the Spill Reporting Regulation of the *Environmental Management Act* (2003) are not assessed in the context of surface water quality; such events are discussed in Chapter 21. However, hydrocarbon products in surface water runoff have the potential to adversely affect surface water quality on a local scale.

Fuel storage on site will include a diesel filling station for heavy mine equipment with four 45,000 L tanks (double-walled) and two fueling pumps. The light vehicle station comprises a single 7,000 L tank and a single fueling pump. Both fuelling stations will be located on the southern edge of the main shop pad area. Small amounts of hydrocarbons released from other Project activities, such as operation and refuelling of mobile mining equipment, will be captured by mine site drainage infrastructure throughout the site.

Potential effects from hydrocarbon releases may occur during Construction and Pre-Production, Operations, and Reclamation and Closure. No effects are anticipated during Post-Closure as the fueling stations and all heavy equipment and vehicles will be removed from the site prior to mine closure.

Pit Dewatering

During active mining of the pits in the Operations phase, it will be necessary to dewater each pit through the use of drainage ditches, berms, sumps and pumps. After mining has ceased, each pit will be backfilled with waste material which will ultimately negate the need for pumping infrastructure. Because the spill points of each pit are located below the observed groundwater elevation, once backfilled they will saturate via groundwater inflow, and eventually discharge water Post-Closure.

Potential parameters of concern associated with pit water during Operations include suspended sediments, nitrogenous compounds (e.g., ammonia, nitrate, and nitrite) from blasting residues, sulphides, and metals leached from pit walls. However, laboratory tests (e.g., Kirk et al., 2017; Enviromin, Inc., 2022 [Appendix 3-B]), field research at a coal mine in northeastern B.C. (Bianchin et al., 2013), and Teck's saturated rock fill facility in the Elk Valley (e.g., Teck, 2018) show that selenium and nitrate are effectively reduced in mildly suboxic saturated zones once open pits are backfilled and saturated with groundwater inflow.

11.5.2.2.4 Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects

Activities associated with a change in surface water quality from disposal of mine rock and coal rejects are generally most relevant to the Operations phase, except as noted in the description of activities below.

Metal leaching/acid rock drainage (ML/ARD) from the mine rock facilities have the potential to result in increased concentrations of selenium or other substances (e.g., cadmium, nitrate) in the mine site drainage released to the receiving environment during the Operations, Reclamation and Closure, and Post-Closure phases. No effects to surface water quality from ML/ARD are anticipated during the Construction and Pre-Production phase prior to the start of mining.

Acid-base accounting for the Project indicated a generally low potential for ARD in the Mist Mountain Formation and Fernie Formation mine rock due to an overall low sulphur content combined with excess neutralization potential (Appendix 11-C; SRK Consulting, Inc. [SRK], 2021a). A conservative sulphur concentration of 0.1% was selected to represent low sulphur concentrations; no samples generated acidic paste pH below this value (SRK, 2021a). Isolated potentially ARD generating strata and/or samples have been identified, but the sulphur content is only marginally above 0.1% at 0.12%. The overall conclusion is that ARD potential for mine rock is low, which is supported by the lack of acid drainage throughout the Elk Valley despite the long history of coal mining in the area and significant amount of monitoring that has taken place over the past 40 years or so. Coal rejects are not expected to be acid generating based on the

presence of low levels of carbonate minerals, which appear to provide sufficient buffering of low levels of acidity, and the disposal configuration designed to limit oxidation.

Trace element characterization for the Project indicated similar potential for leaching from mine rock compared to other sites in the Elk Valley, with the primary constituent of concern being selenium (SRK, 2021a). Selenium concentrations in rocks collected within the Project footprint were consistent with other studies in the Elk Valley, with concentrations varying from 0.80 to 2.2 milligrams per kilogram (mg/kg) on average, with lower concentrations in sandstones and higher concentrations in mudstones. Other elements were elevated in the mine rock, such as antimony, barium, molybdenum, copper, nickel, zinc, nickel, cobalt, arsenic, mercury, and cadmium (SRK, 2021a). However, laboratory test results did not indicate any significant upward trends in release rates for these parameters, and trace element concentrations were comparable to those observed elsewhere in the Elk Valley.

11.5.2.2.5 Change in Surface Water Quality from Surface Water – Groundwater Interactions

Groundwater is expected to interact with the creeks and drainages within the Project footprint. Based on the conceptual model of the groundwater system and field observations, drainages and creeks in the area are expected to be both gaining (i.e., groundwater is entering the system and contributing to baseflow) and losing (i.e., surface water from watercourses goes sub-surface, resulting in reduced baseflow) with regard to groundwater along their lengths.

The inflow and outflow of groundwater is expected to more or less balance out, and net flow to/from groundwater along the length of the drainages is assumed to be negligible compared to the flows conveyed in the channel under normal conditions. A flow accretion survey conducted in 2018 indicated that West Alexander Creek is a gaining stream (groundwater discharges to surface water) in its upper reaches where overburden thickness is the least, and transitions to a losing stream (surface water is lost to groundwater) in the lower reaches just upstream of the Main Sediment Pond, where overburden becomes greater. Upper Alexander Creek includes both gaining and losing reaches, and transitions to a losing stream slightly upstream of the confluence with West Alexander Creek. Additional details are provided in Chapter 9, Section 9.3.3.

Construction and Pre-Production

No potential adverse effects to surface water quality as a result of interactions with groundwater are anticipated during Construction and Pre-Production, as groundwater effects are anticipated to be limited to changes in local groundwater flow patterns due to construction of the quarry, Interim Sediment Pond, and Grave Creek Reservoir. Additional details are provided in Chapter 9, Section 9.5.2.

Operations, Reclamation and Closure, and Post-Closure

Potential adverse effects to shallow groundwater aquifers may contribute to surface water systems in groundwater discharge zones along West Alexander Creek within the Project footprint and may travel further in deep groundwater. During Operations, Reclamation and Closure, and Post-Closure, changes to groundwater quality via seepage from mine disturbed areas, particularly the Mine Rock Storage Facility, could potentially result in changes to surface water quality. It is expected that the majority of potentially affected groundwater will discharge to ground surface relatively close to the Mine Rock Storage Facility and will be captured by the Main Sediment Pond. Some limited affected groundwater remaining in the groundwater system may flow downgradient towards the Alexander Creek valley, mixing with non-

contact waters from other parts of the catchment. Contact groundwater will move slowly downgradient and remain at depth. Contact groundwater in near surface materials may discharge to surface water at stream gaining reaches, with reducing concentrations of constituents in groundwater expected over time (SRK, 2021b). Groundwater temporal flow paths will be long (10s to 100s of years) and the combination of mixing with other groundwater inputs and any natural attenuation would further reduce potential risk of impact from these waters if they discharged to the surface.

Modelling suggests that near surface seepage in the overburden unit would not extend beyond approximately 500 m down-gradient of the Mine Rock Storage Facility (to the approximate location of the Main Sediment Pond) within 100 years. Seepage in the deeper bedrock system could travel on the order of 1,000 m down-gradient of the Mine Rock Storage Facility over the same time period (SRK, 2021b). Simulations assuming the sediment pond as a source suggest that contact water could travel as far as 2,500 m downstream of the pond, much further than seepage from the Mine Rock Storage Facility. However, lining the sediment ponds will reduce the potential for any affect, so these estimates are considered conservative.

Surface water quality predictions indicate no substantial change to parameter concentrations in Grave Creek, as groundwater seepage and effects to groundwater quality are expected to be unmeasurable at any appreciable distance from the area of the North Pit.

11.5.2.2.6 Change in Surface Water Quality from Sediment Pond Discharge

A series of two sediment ponds are proposed for managing the combined runoff from the mine footprint and non-contact water from the upper western slopes of West Alexander Creek as the mine development advances. These ponds will be placed downstream of the Mine Rock Storage Facility and will be developed through the mine life to accommodate the advancing mine rock placement and provide a means to collect and temporarily retain mine affected water to meet Technical Guidance 7 *Environmental Management Act* requirements (B.C. MOE, 2015). Initially, the Interim Sediment Pond will capture seepage and runoff from the mine rock piles. During Year 4 of Operations, the Main Sediment Pond will be built downstream of the ultimate Mine Rock Storage Facility footprint. Both the Interim Sediment Pond and the Main Sediment Pond will be lined to prevent infiltration into groundwater. In addition, the grading and site drainage around the Coal Handling Process Plant, maintenance/office complex, and ROM pad will be designed such that runoff from these areas will also drain to the West Alexander Creek catchment. This infrastructure includes haul roads, the plant and warehouse/shop site, and coal transfer and stockpile areas. During Year 5, the Interim Sediment Pond will be decommissioned.

The Main Sediment Pond will be active throughout the life of the mine into the Post-Closure phase and will be decommissioned once all water quality objectives have been met. Specific details on the sediment pond designs are provided in Chapter 3.

Construction and Pre-Production

The Interim Sediment Pond will be built during the Construction and Pre-Production phase. The Interim Sediment Pond will take approximately three to five months to fill, dependent on the time of year. Consequently, no geochemical potential adverse effects to surface water quality from sediment pond discharge are anticipated during the Construction and Pre-Production phase. Downstream flows will be affected during the filling of the Interim Sediment Pond.

Operations through Reclamation and Closure

During Operations, all mine site drainage is collected in the sediment ponds, either the Interim Sediment Pond during the first four years of Operations or the Main Sediment Pond beyond Year 4. Water in the sediment ponds will be monitored to confirm it meets approved discharge limits and released into the West Alexander drainage where it will flow to the confluence with Alexander Creek. Alexander Creek joins Michel Creek downstream near Highway 3, which subsequently discharges into the Elk River upstream of Sparwood.

Discharge from the sediment ponds has the potential to contain elevated levels of TSS, selenium, nitrate, sulphate, and other trace elements. Flows entering West Alexander Creek from the sediment ponds have the potential to result in erosion to the natural creek bed, causing additional TSS loads downstream. In addition, calcite formation can change the characteristics of stream substrates by cementing rocks together, adversely affecting habitat for fish and invertebrates. Calcite formation is frequently observed in the Elk Valley in streams downstream of mining activities (Robinson and MacDonald, 2014).

A preliminary calcite assessment for the Project (SRK, 2021c) was conducted to assess the potential for calcite precipitation to occur in West Alexander Creek and Alexander Creek downstream of the sediment ponds. Additional details on the calcite assessment are provided in Appendix 11-D. The calcite assessment indicates that deposits can be expected to form in West Alexander Creek to the confluence with Alexander Creek, may extend into Alexander Creek, and are expected to increase in extent in West Alexander Creek as the mine footprint increases (SRK, 2021c).

The Main Sediment Pond will continue to operate during the Reclamation and Closure phases, with the potential for similar effects to occur as described for Operations. Ongoing monitoring of the discharge water quality from the Main Sediment Pond will be required throughout the Reclamation and Closure phases.

Post-Closure

Management of the Main Sediment Pond discharge will continue Post-Closure until all water quality objectives have been met. The Main Sediment Pond will then be decommissioned to re-establish flows in West Alexander Creek. Decommissioning will require the removal of sediment from the dam structure, constructing additional spillways, and breaching the main dam. Sediment removed from the pond will be placed in the Mine Rock Storage Facility for disposal.

Decommissioning of the Main Sediment Pond has the potential to affect surface water quality in the receiving environment by increased levels of TSS and turbidity and may result in erosion to the natural creek bed, causing additional TSS loads downstream.

11.5.2.3 Transboundary Effects

The Project is located approximately 5 km west from the Alberta border and 85 km north from the Montana border in the United States of America. As discussed in Chapter 1, Section 1.3.3, the nearest federal lands to the proposed Project are the ?aq'am First Nation Bummer's Flat 1 Reserve (approximately 69 km southwest), Stoney Nakoda Edan Valley 216 Reserve (approximately 70 km northeast), Tobacco Plains 2 (approximately 80 south), Piikani Nation Peigan Timber Limit 147B (approximately 52 km east in Alberta), and Parcels 73 and 82 of the Dominion Coal Blocks (approximately 20 and 40 km southwest,

respectively). Federal land is not required to facilitate the Project and the Project does not overlap with any federal land. Of the federal lands listed above, only Parcel 73 and a small portion of Parcel 82 of the Dominion Coal Blocks are located within the Aquatic RSA; the other federal lands are located outside the Elk River watershed and therefore effects to surface water quality will not occur within these lands. Although Parcel 73 and a small portion of Parcel 82 are located within the Aquatic RSA, changes to surface water quality within these federal lands are not expected as the watercourses that have the potential to be affected by the Project (i.e., West Alexander Creek, Alexander Creek, the lower reaches of Michel Creek, and the Elk River) do not overlap with the Dominion Coal Blocks.

There is the potential for transboundary effects to surface water quality in Lake Koochanusa to occur during the Operations, Reclamation and Closure, and Post-Closure phases of the Project as a result of the Interim and Main Sediment Pond discharges to the receiving environment in West Alexander Creek. Flow from the sediment ponds will move downstream from Alexander Creek to Michel Creek and subsequently the Elk River to its outlet with Lake Koochanusa, approximately 80 km downstream of the Project. Transboundary effects into Alberta will not occur as a result of the Project as all watersheds within and surrounding the Project footprint are located on the western side of the Continental Divide.

11.5.3 Mitigation Measures

The mitigation measures proposed for surface water quality are based on available BMPs, provincial and federal guidance documents, mitigation measures conducted and accepted for similar projects, and professional judgement. The identification and selection of technically and economically feasible mitigation measures followed the mitigation hierarchy approach outlined by the provincial *Environmental Mitigation Policy* and related *Environmental Mitigation Procedures* (Ministry of Environment, 2014a and 2014b). Technical and economic constraints dictated the highest level of the mitigation hierarchy that could be achieved for managing each potential effect.

Mitigation measures were identified for each potential effect on surface water quality. For the purposes of this assessment, mitigation measures are defined to include Project design features, procedures, or practices that will reduce or eliminate Project-related effects to surface water quality. Potential Project-related changes to surface water quality will be reduced through design mitigation, regulatory requirements, BMPs, including management plans, monitoring, and adaptive management. Where mitigation measures are considered to be completely effective, potential Project effects to surface water quality are not identified as residual effects.

The following subsections describe mitigation for the following potential Project effects on surface water quality from:

- Change in surface water quality from non-contact water runoff;
- Change in surface water quality from dust deposition;
- Change in surface water quality from mine site drainage;
- Change in surface water quality from disposal of mine rock and coal rejects;
- Change in surface water quality surface water – groundwater interactions; and
- Change in surface water quality from sediment pond discharge.

11.5.3.1 Mitigation Measures for Change in Surface Water Quality from Non-Contact Water Runoff

The primary measure to mitigate a change in surface water quality from non-contact water runoff is to reduce the potential for erosion and the transportation of material in surface runoff to the West Alexander Creek, Alexander Creek, Grave Creek, and Elk River drainages through the implementation of the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4). Specific mitigation measures, as organized by mitigation hierarchy level, include:

1. Avoid:
 - Earth moving activities throughout the life of mine will be scheduled to limit the duration of exposed soils and to avoid such activities during wet and/or windy seasons, where possible;
 - Sediment loading in runoff will be reduced by the application of standard industry practices (e.g., benching, erosion blankets, silt fencing) to intercept sediment before it reaches the receiving environment; and
 - Regular inspections will be conducted to confirm drainage, erosion, and sediment control measures are effective and functioning properly, which will allow for timely repairs and adjustments as required.
2. Minimize:
 - NWP's site strategy for surface water (detailed in the Site Water Management Plan in Chapter 33, Section 33.4.1.8) includes limiting the mine disturbance footprint and avoiding affecting additional drainages beyond West Alexander and Grave Creeks;
 - Further to the north of the Grave Creek-West Alexander Creek drainage divide, runoff will be directed to small catchment sumps prior to release or managed with localized erosion mitigations for small, isolated areas of disturbance (e.g., minor road cuts); and
 - Surface water that cannot be diverted is captured in sediment ponds prior to release into the West Alexander Creek drainage.
3. Restore On-Site:
 - Progressive reclamation and re-vegetation will occur throughout the mine life to minimize erosion potential and reduce the Project footprint, minimizing the potential for runoff effects to surface water.

No residual effects from non-contact water runoff are predicted on surface water quality through the implementation of the Erosion and Sediment Control Plan and Site Water Management Plan. Surface water quality monitoring and adaptive management through the Site Water Management Plan and permit conditions will be used to validate the efficiency of the proposed mitigation measures.

11.5.3.2 Mitigation Measures for Change in Surface Water Quality from Dust Deposition

The primary measure to mitigate a change in surface water quality from dust deposition is to reduce the potential for dust to settle in the West Alexander Creek, Alexander Creek, Grave Creek, and Elk River drainages through the implementation of the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1). Specific mitigation measures, as organized by mitigation hierarchy level, include:

1. Avoid:
 - Earth moving activities throughout the life of mine will be scheduled to limit the duration of exposed soils and to avoid dust-generating activities during windy periods, where possible;

- Dust generation from mining activities and equipment will be contained through the application of standard emission control measures (e.g., fabric covers for the coal stockpiles and conveyers, a dust canopy for the ROM dump hopper) to intercept dust before it reaches the receiving environment; and
 - Regular inspections will be conducted to confirm air quality and dust control measures are effective and functioning properly, which will allow for timely maintenance and adjustments as required.
2. Minimize:
- The layout of the site has been designed to minimize travel distances between operations (e.g., between the pits and the Coal Handling Process Plant) in order to reduce vehicle travel distances and speeds that would result in additional generation of dust emissions;
 - Enforcement of low speed limits for vehicular traffic throughout the site;
 - Unpaved roads will be regularly maintained and kept in good repair, including regular compaction and use of coarse aggregate with low silt content, where possible;
 - Establish and follow site Soil Management Plan (Chapter 33, Section 33.4.1.9);
 - Soil stockpiles will be placed at appropriate locations, and soil stored and shaped in ways to maintain slope stability and reduce moisture content loss, including establishment of vegetation to reduce exposure to wind and water erosion; and
 - Water or dust suppression methods will be used to mitigate dust generation in areas including unpaved roads, work areas, and storage piles, if necessary. Water for dust suppression will be withdrawn from the Interim Sediment Pond and Grave Creek Reservoir for the first five years of Operations, and then supplemented from the North Pit sumps for the remainder of the mine life.
3. Restore On-Site:
- Progressive reclamation and re-vegetation will occur throughout the mine life to minimize wind erosion potential and reduce the Project footprint, minimizing the potential for dust deposition to nearby watercourses.

A full list of mitigation measures for dust emissions is provided in Chapter 6. Residual effects from dust deposition are not predicted on surface water quality through the implementation of the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1), and dustfall monitoring and adaptive management will be used to validate the efficiency of the proposed mitigation measures.

11.5.3.3 Mitigation Measures for Change in Surface Water Quality from Mine Site Drainage

As discussed in Section 11.5.2.2.3, mine site drainage has the potential to affect surface water quality primarily as a result of blasting activities, release of hydrocarbons, and pit dewatering. Although the mine site drainage will include mine affected water discharged from the Mine Rock Storage Facility, mitigation measures for ML/ARD are discussed separately in Section 11.5.3.4. The primary measure to mitigate potential effects to surface water quality from other constituents contained in mine site drainage will be to direct all contact water to the Interim and Main Sediment Ponds for settling to remove suspended solids and allow the testing of water quality prior to discharge into West Alexander Creek, as detailed in the Site Water Management Plan (Chapter 33, Section 33.4.1.8). In addition, effects from mine site drainage will be minimized through limiting the mine disturbance footprint and avoiding affecting additional drainages beyond West Alexander and Grave Creeks.

11.5.3.3.1 Mitigation Measures for Nitrogen Loading from Explosives Use

The location of the explosives factory has been selected based on requirements in the Natural Resources Canada (NRCan) *Guidelines for Bulk Explosives Facilities Minimum Requirements G05-01* (2014), *National Standard of Canada Explosives – Quantity Distances*, document number CAN/BNQ 2910-510, 2015), and the *Health, Safety and Reclamation Code for Mines in British Columbia* (Ministry of Energy, Mines and Low Carbon Innovation, 2021). This facility will be located approximately 1.4 km from the active mining area in the northeast portion of the Project footprint on a separate access off the Grave Creek Road. Construction and maintenance of the facilities will be the responsibility of the selected licenced blasting contractor, in addition to the environmental, health, and safety requirements for the operation of the explosives factory. All water used in the decontamination of the bulk explosive delivery trucks and other equipment will be collected from the explosives factory wash bay and stored in a secure holding tank and disposed offsite by the blasting contractor at an approved facility.

Mitigation measures to minimize nitrogen loading to surface water during blasting activities are described in the Nitrate Management section of the Site Water Management Plan (Chapter 33, Section 33.4.1.8) and include, as organized by mitigation hierarchy level:

1. Avoid:
 - Blasting activities will be limited to within the North, East, and South Pits, avoiding additional nitrogen loading to other areas of the site; and
 - Look to use non-nitrate explosives as they become commercially available.
2. Minimize:
 - Bagging all blastholes to keep the ANFO dry;
 - Minimizing the use of emulsion bulk explosives;
 - Optimizing the blasthole size and pattern design;
 - Limiting the sleep time of a loaded pattern to one week; and
 - Training of employees to limit spillage of explosive agents on the blast pattern.

In addition, the proposed layered mine rock design discussed in Section 11.5.3.4 is intended to reduce nitrate leaching from blasting residues on the mine rock. With the mitigation measures outlined in the Site Water Management Plan in place, a direct residual effect to surface water quality as a result of nitrogen loading from blasting activities is not anticipated.

11.5.3.3.2 Mitigation Measures for Hydrocarbons

Fuelling activities and bulk fuel storage will occur in designated areas only. Fuel storage and fuelling stations will be located on the southern edge of the main shop pad area, and service fluid tanks will be located adjacent to the maintenance shop on a bermed secondary containment pad. Vehicle washing and routine maintenance activities will also occur in a lined facility or equivalent. Mitigation measures to minimize hydrocarbon releases to surface water are described in the Spill Prevention, Control, and Countermeasures Plan (Chapter 33, Section 33.4.1.10) and include, as organized by mitigation hierarchy level:

1. Avoid:
 - Designation of appropriate locations where mobile equipment will be refueled, lubricated, and serviced with appropriate containment measures; and
 - All fuels will be delivered to site by a licensed contractor.

2. Minimize:

- Implementing procedures for handling and storing fueling and fuel transfer;
- Developing, implementing, and documenting regularly scheduled site inspections, which include fueling locations and shops;
- Inspecting vehicles and equipment regularly for leaks and document their condition;
- Developing, implementing and documenting a preventative maintenance program for all vehicles and equipment on site; and
- Placement of spill kits at high risk locations (i.e., in areas with the highest risk activities).

Residual effects from hydrocarbons are not predicted on surface water quality through the implementation of the Spill Prevention, Control, and Countermeasures Plan, and monitoring and adaptive management will be used to validate the efficiency of the proposed mitigation measures.

11.5.3.3.3 Mitigation Measures for Pit Dewatering

During active mining of the pits in the Operations phase, it will be necessary to dewater each pit through the use of drainage ditches, berms, sumps and pumps. Water collected and pumped out of the North and East Pits will be collected through internal ditches and discharged to the Interim Sediment Pond up to Year 4, then into the Main Sediment Pond from Year 5 until closure. After mining has ceased, each pit will be backfilled with waste material, which will ultimately negate the need for pumping infrastructure. Research shows that selenium and nitrate are effectively reduced in mildly suboxic saturated zones once open pits are backfilled and saturated with groundwater inflow (Kirk et al., 2017), minimizing the potential for effects to surface water quality. Mitigation measures to minimize effects to surface water quality from pit dewatering are described further in the Site Water Management Plan (Chapter 33, Section 33.4.1.8).

Residual effects from pit dewatering are not predicted on surface water quality through the implementation of the Site Water Management Plan, and monitoring and adaptive management will be used to validate the efficiency of the proposed mitigation measures.

11.5.3.4 Mitigation Measures for Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects

The acid rock drainage potential for mine rock and coal rejects is considered low, which is supported by the lack of acid drainage throughout the Elk Valley. However, metal leaching, specifically relating to the release of selenium from mine rock, has the potential to result in adverse effects to surface water quality downstream of the Mine Rock Storage Facility. The primary measure to mitigate changes in surface water quality from ML/ARD is a layered mine rock design to reduce selenium and nitrate leaching. This approach is based on a layering of coal rejects and mine rock. The reject layers will act as suboxic environments where oxygen, nitrate, and selenate will be reduced to water, nitrogen gas, and selenite, or elemental selenium, respectively (Enviromin, Inc., 2022; Appendix 3-B). Mitigation measures to minimize ML/ARD are described in the Site Water Management Plan and include, as organized by mitigation hierarchy level:

1. Minimize:

The placement of mine rock outside of the pits will blend potentially acid generating (PAG) and non-PAG materials such that the resulting mixture performs as non-PAG. Mine rock will initially be placed outside of the valley-floor area of West Alexander Creek in the area commonly referred to as the Moose Meadow (located between the North Pit and East Pit footprints; Figure 11.5-1).

During the first few years, the proposed mine rock/coal rejects co-disposal design method will be evaluated to determine if co-mingling of coal rejects with mine rock successfully mitigates the mobilization of selenium and nitrate species in mine rock stockpile runoff (see Chapter 33, Section 33.4.1.8). If the co-disposal method proves successful, as predicted, placement of mine rock in later mining years will proceed in the West Alexander Creek Valley and will ultimately occupy a large portion of the creek basin. The Mine Rock Storage Facility will be designed to limit oxygen and water infiltration by interlayering and capping mine rock with plant rejects and filtered process waste material. The layering plan eliminates the need for a separate coal process wastes storage facility; therefore, a conventional tailings dam or filtered waste pile is not required. The layering approach is also expected to reduce, but not eliminate, the potential for calcite precipitation due to reduced oxygen entry (SRK, 2021c; Appendix 11-D).

Sediment ponds will be built downstream of the Mine Rock Storage Facility in two phases, both of which will flow into West Alexander Creek. Initially, the Interim Sediment Pond will capture seepage and runoff from the mine rock piles and water from pit dewatering. During Year 4 of Operations, the Main Sediment Pond will be built downstream of the ultimate Mine Rock Storage Facility footprint and then the Interim Sediment Pond will be decommissioned. The Main Sediment Pond will be active throughout the life of mine into the Post-Closure phase and will be decommissioned once all water quality objectives have been met.

The Mine Rock Storage Facility will require ongoing maintenance to maintain roads, berms, and water management/ sediment control features. Additional details on the mine rock placement are provided in the Metal Leaching/Acid Rock Drainage Management section of the Site Water Management Plan. The North Pit and East Pit will be suitable for placement of mine rock because the mine rock will be contained inside the pit walls. Water accumulating inside the pits will saturate the lower portions of the mine rock fill, limiting oxidation and subsequent selenium release. Selenium removal from contact waters has been demonstrated directly; selenium concentrations in groundwater and outflows from saturated backfills are much lower than observed for comparable mine rock in conventional ex-pit mine rock at several operating mines (e.g., Bianchin et al., 2013).

2. Restore On-Site:

The progressive reclamation of available Mine Rock Storage Facility areas has been integrated into the overall mine schedule and soil handling plan in order to limit exposure time after the mine rock has been placed to final grade and re-sloped.

Monitoring and adaptive management will be used to validate the efficiency of the proposed ML/ARD mitigation measures through the implementation of the Site Water Management Plan. However, with these mitigation measures in place, there is still a potential for a residual effect to surface water quality as a result of ML/ARD and nitrate leaching.

11.5.3.5 Mitigation Measures for Change in Surface Water Quality from Surface Water – Groundwater Interactions

During Operations, Reclamation and Closure, and Post-Closure phases, changes to groundwater quality via seepage from mine disturbed areas, particularly the Mine Rock Storage Facility, may result in changes to surface water quality. Potentially affected groundwater will discharge to the surface relatively close to

the Mine Rock Storage Facility and will be captured by the sediment ponds. Runoff and seepage water will be controlled using diversion ditches and managed in the lined or equivalent sediment ponds, minimizing leakage and any potential effects to groundwater quality.

Groundwater infiltration/seepage into the ground has the potential to adversely affect groundwater quality; however, effects are expected to be effectively mitigated using impermeable liners to prevent losses. Mitigation measures to collect groundwater from the Mine Rock Storage Facility is therefore not considered necessary at this time. If the Mine Rock Storage Facility does not perform as expected, and groundwater mitigation is deemed appropriate, the West Alexander Creek valley represents an ideal location for a conventional collection or cut-off system. Additional details on mitigation measures for groundwater are discussed in Chapter 9 and in the Site Water Management Plan. However, with these mitigation measures in place, there is still a potential for a residual effect to surface water quality as a result of surface water – groundwater interactions downstream of the sediment ponds.

11.5.3.6 Mitigation Measures for Change in Surface Water Quality from Sediment Pond Discharge

All contact water from the site will be diverted into the sediment ponds, which will be fully lined with impermeable geomembrane liners to minimize seepage losses. These ponds will be placed downstream of the Mine Rock Storage Facility and will be developed through the mine life to accommodate the advancing mine rock placement and provide a means to collect and temporarily contain mine affected water. The sediment ponds are sized according to B.C. Ministry of Environment Technical Guidance 7 *Environmental Management Act* requirements (B.C. MOE, 2015). They are sized to settle particles having a diameter of 5 to 10 microns or greater during conveyance of runoff resulting from the 10-year, 24-hour storm event. They also include riprap spillway structures and containment berms to contain and convey the 200-year, 24-hour storm and maintain adequate freeboard.

Ongoing monitoring of the discharge quality from the sediment ponds will be required as part of the mine's environmental program, as discussed in the Fish and Fish Habitat and Site Water Management Plans (Chapter 33, Sections 33.4.1.5 and 33.4.1.8). Primary mitigation measures are detailed in the Site Water Management Plan and include, as organized by mitigation hierarchy level:

1. Avoid: Clean, non-contact water will be diverted away from the sediment ponds and other Project infrastructure, where possible, to maintain water quality and natural drainage and reduce the burden on the sediment ponds.
2. Minimize: Sediment ponds will be sized appropriately to minimize seepage losses and convey runoff during storm events. Anti-scaling agents will be added as required to minimize the potential for calcite formation downstream of the discharge, should the layering approach not sufficiently reduce the potential for calcite precipitation below the EVWQP long-term calcite index target of ≤ 0.50 in mine-exposed streams.
3. Restore On-Site: Progressive reclamation and re-vegetation will occur throughout the mine life to reduce the Project footprint, minimizing the potential for surface runoff from mine disturbed areas. The Main Sediment Pond will be decommissioned Post-Closure once surface water quality objectives have been met.

Monitoring and adaptive management will be used to validate the goals and water management strategies detailed in the Site Water Management Plan and Fish and Fish Habitat Management Plan.

However, with these mitigation measures in place, there is still a potential for residual effects on surface water quality from sediment pond discharge.

11.5.3.7 Summary of Mitigation Measures for Surface Water Quality

The key mitigation measures proposed to mitigate potential effects on surface water quality are summarized in Table 11.5-3. This table also identifies the anticipated residual effects that will be carried forward in the characterization of residual effects, significance, and likelihood and confidence.

Mitigation measures proposed to reduce adverse effects to surface water quality are generally accepted, understood, and proven to effectively reduce environmental effects related to surface water quality. Where mitigation measures do not or may not mitigate all effects or if there is an unknown or moderate level of confidence in their effectiveness, the effect was carried forward for further analysis of residual effects. Mitigation measures that are expected to completely mitigate potential effects with a high level of confidence based on their proven effectiveness elsewhere were classified as having no expected residual effects.

Other technically and economically feasible mitigation measures specific to selenium treatment were considered in Chapter 2; however, approaches such as a conventional MSRF would increase operating costs as it would require ongoing selenium treatment with an active water treatment plant, whereas the layer cake method is anticipated to be a sustainable long-term source control for selenium.

If monitoring indicates that the effectiveness of mitigation measures and reclamation activities is lower than predicted, further mitigation may be required as per adaptive management strategies outlined in the Site Water Management Plan (Chapter 33, Section 33.4.1.8). According to B.C.'s Technology Readiness Level (TRL) Assessment (TRA) Guidance issued in August 2022 (B.C. Ministry of Energy, Mines and Low Carbon Innovation and B.C. Ministry of Environment and Climate Change Strategy, 2022) and the Best Achievable Technology Assessment to Inform Waste Discharge Standards Handout (and B.C. Ministry of Environment and Climate Change Strategy, 2021), the TRA is part of Step 3 of the Best Achievable Technology (BAT) process. The BAT process (along with the now embedded TRA) is a requirement of Chapter 5 of the *Mines Act/Environmental Management Act* Joint Application Information Requirements (JAIR). As such, it will be performed and submitted in that application.

In this Application/EIS, several mitigations were developed and implemented to prevent contamination of the receiving waters. Some, like the Mine Rock Storage Facility, are well-known technologies with analogous implementations. However, there are site-specific uncertainties that need to be addressed through a Technology Maturation Plan before implementation. The Technology Maturation Plan is a part of the TRA that is completed during the BAT process for the JAIR. Water quality models with and without the assumption of successful implementation of the Mine Rock Storage Facility layering technology will be used for screening of discharge points in the BAT and associated TRA. This will be used to determine whether additional water treatment or mitigation strategies are necessary and determine that those selected are at a relevant TRL for implementation. To begin the process of developing additional water treatment strategies and opportunities for the Project, NWP has completed an initial Water Mitigation Technology Readiness review (Maven Water & Environment and Integrated Sustainability, 2023) located in Appendix 11-E. This initial assessment is not a BAT evaluation; but identifies the next steps for further developing the water management and treatment plan.

Table 11.5-3: Summary of Proposed Mitigation Measures related to Surface Water Quality

Potential Effect	Key Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Surface Water Quality from Non-Contact Water Runoff	<ul style="list-style-type: none"> Limit erosion and contain sediment through the application of standard industry practices Conduct regular inspections to confirm control measures are effective and functioning properly Divert clean runoff around mine disturbed areas, where possible Capture clean surface water that cannot be diverted in sediment ponds prior to release Limit the mine disturbance footprint through Project design and progressive reclamation 	<ul style="list-style-type: none"> Erosion and sediment control measures (e.g., silt fencing) are standard industry practice and proven to be effective Regular inspection of erosion and sediment control measures allows for timely repairs and adjustments as required Minimizing the Project footprint minimizes potential erosion and sedimentation effects to surface water 	<ul style="list-style-type: none"> Construction and Pre-Production Operations Reclamation and Closure 	High	No
Change in Surface Water Quality from Dust Deposition	<ul style="list-style-type: none"> Limit dust generation and emissions through the application of standard industry practices and emissions control measures Conduct regular inspections to confirm control measures are effective and functioning properly Limit the mine disturbance footprint through Project design and progressive reclamation 	<ul style="list-style-type: none"> Emission control measures (e.g., fabric covers, dust suppression) are standard industry practice and proven to be effective Regular inspection of emission control measures allows for timely repairs and adjustments as required Minimizing the Project footprint, particularly exposed soils, minimizes potential wind erosion and dust generation 	<ul style="list-style-type: none"> Construction and Pre-Production Operations Reclamation and Closure 	High	No

Potential Effect	Key Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Surface Water Quality from Mine Site Drainage	<p>Nitrogen Loading:</p> <ul style="list-style-type: none"> • Following provincial and federal requirements for the storing and handling of explosives • Collection and disposal of decontamination water off site; • Bagging all blastholes to keep the ANFO dry • Minimizing the use of emulsion bulk explosives • Optimizing the blasthole size and pattern design • Limiting the sleep time of a loaded pattern to one week • Training of employees to limit spillage of explosive agents on the blast pattern 	<ul style="list-style-type: none"> • Standard industry practices are proven to be effective to reduce the potential for nitrogen loading from explosives use. However, some nitrogenous residues are likely to remain on mine rock after blasting that is placed in the Mine Rock Storage Facility 	<ul style="list-style-type: none"> • Construction and Pre-Production • Operations 	High	No
	<p>Hydrocarbons:</p> <ul style="list-style-type: none"> • Restricting the storage and transfer of fuel to certain areas • Implementing procedures for handling and storing fuel and fuel transfer • Conducting regular site and vehicle inspections • Preventative maintenance for all vehicles and equipment on site 	<ul style="list-style-type: none"> • Standard industry practices for handling, storing, and transferring fuel are proven to be effective at reducing the release of hydrocarbons to the receiving environment • Regular inspections of the site, vehicles, and equipment allows for timely repairs and adjustments as required 	<ul style="list-style-type: none"> • Construction and Pre-Production • Operations • Reclamation and Closure 	High	No

Potential Effect	Key Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	<p>Pit Dewatering:</p> <ul style="list-style-type: none"> • During active mining, dewatering will be carried out using drainage ditches, berms, sumps and pumps. Pit dewatering will be coordinated to meet overall water quality objectives • Once backfilled and allowed to fill with groundwater inflows, selenium and nitrate are effectively reduced in mildly suboxic saturated rock fill 	<ul style="list-style-type: none"> • Standard industry practices for dewatering are proven to be effective at reducing effects in the receiving environment 	Operations	High	No
Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects	<ul style="list-style-type: none"> • Engineered layering of coal rejects and mine rock to limit ML/ARD • Saturated backfill of mine rock in the East and North Pits • Progressive reclamation of the Mine Rock Storage Facility 	<ul style="list-style-type: none"> • The mine rock placement outside of the pits will blend PAG and non-PAG materials such that the resulting mixture performs as non-PAG. The reject layers will act as suboxic environments where oxygen, nitrate and selenate will be reduced. The proposed design will be evaluated during the first few years of Operations to determine if successful • Selenium removal from contact waters has not been demonstrated directly, but selenium concentrations from saturated backfills are much lower than observed for conventional ex-pit mine rock at several operating mines; and • Progressive reclamation will limit exposure time of the Mine Rock Storage Facility 	<ul style="list-style-type: none"> • Operations • Reclamation and Closure • Post-Closure 	Unknown	Yes

Potential Effect	Key Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Surface Water Quality from Surface Water – Groundwater Interactions	<ul style="list-style-type: none"> Installation of impermeable liners in the Interim and Main Sediment Ponds 	<ul style="list-style-type: none"> Impermeable geomembrane liners are proven to be effective in preventing leakage/seepage to groundwater. However, the potential for seepage of contaminated groundwater to surface water downstream of the sediment ponds remains 	<ul style="list-style-type: none"> Operations Reclamation and Closure Post-Closure 	Moderate	Yes
Change in Surface Water Quality from Sediment Pond Discharge	<ul style="list-style-type: none"> Diverting clean, non-contact water away from the sediment ponds, where possible Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events Limit the mine disturbance footprint through Project design and progressive reclamation Monitoring and adaptive management 	<ul style="list-style-type: none"> Appropriately sized sediment ponds are proven to be effective to settle particles Anti-scaling agents are proven effective in reducing calcite formation Minimizing the Project footprint reduces the amount of surface runoff from mine disturbed areas, reducing the burden on the sediment ponds However, the potential for discharge of water containing elevated concentrations of TSS, selenium, nitrate, or other parameters exists should other upstream mitigation methods (e.g., mine rock management) not operate as intended 	<ul style="list-style-type: none"> Operations Reclamation and Closure Post-Closure 	Moderate	Yes

11.5.4 Characterization of Residual Effects, Significance, Likelihood, and Confidence

Based on the evaluation of potential Project effects on surface water and related mitigation, potential residual effects that may remain after implementation of proposed mitigation measures include:

- Change in surface water quality from the disposal of mine rock and coal rejects;
- Change in surface water quality due to surface water – groundwater interactions; and
- Change in surface water quality from the sediment pond discharge.

11.5.4.1 Surface Water Quality Assessment Methods

11.5.4.1.1 Water Quality Model

In support of the environmental assessment, a conceptual site-wide water quality (SWWQ) prediction model was developed. The primary objective of the model was to make streamflow and water quality predictions under a number of Project development scenarios, providing a comparative level analysis of the effects of the proposed mine on watercourses within and surrounding the Project footprint. Details on streamflow modelling and results are provided in Chapter 10. A summary of the water quality model approach, assumptions, and screening of contaminants of potential concern is provided in the following subsections. Full details are provided in the Water Quality Prediction Model in Appendix 11-F (SRK, 2021d).

The water quality predictions include all design mitigation measures; that is, model results indicating a change in water quality represent a residual effect to surface water quality after planned mitigation has been considered and implemented. The model considers all three residual effects: the disposal of mine rock and coal rejects, potential surface water - groundwater interactions, and sediment pond discharge.

Approach

The Project SWWQ model was developed using GoldSim simulation software. The GoldSim model was designed as a probabilistic, dynamic simulator running continuously from Pre-Production to Post-Closure for a total simulation duration of 34 years in a sequence of quarter-day to one-day time-steps. The model tracks the accumulation of water and solids in the modelled storage systems and predicts the movement of water and associated chemical loads transported with the water through the Project footprint downstream to the Elk River to its outlet at Lake Koochanusa.

The GoldSim model simulates water quantity and water quality using mathematical simulations of rainfall, snowpack/snowmelt, ice formation/melt, runoff, seepage, and water quality. Chemical mass was modelled conservatively, meaning that chemical reactions in the water were not simulated, and solubility constraints were not enforced in the model transport calculations. Chemical mass was introduced into the model through water quality source terms. Every stream of water that enters or is created in the model was assigned a water quality source term value, as determined by the water quality study described in the geochemical baseline report (SRK, 2021d). Source terms for 43 chemical parameters were developed for both natural and Project-related sources, including:

- Pit wall runoff;
- Seepage through the Mine Rock Storage Facility;

- Natural ground runoff;
- Runoff from the Mine Rock Storage Facility;
- Flow in Harmer Creek; and
- Groundwater inflows.

Water quality predictions for the Project were based on dissolved metals. Total suspended solids (TSS) do not act conservatively due to sedimentation processes and would not be accounted for in the mass balance approach. It was assumed that the proposed on-site sediment ponds designed to meet provincial and industrial standards, will be sufficient for settling of particulates. Specific details on the sediment pond designs are provided in Chapter 3, Section 3.7.5.

Integration with the Elk Valley Water Quality Prediction Model

As required in the provincial AIR (EAO, 2018), the Elk Valley Regional Water Quality Model (RWQM) was provided by ENV as per the Data Use Agreement dated July 30, 2018 (Appendix D of Appendix 11-F). The RWQM predictions include monthly selenium, nitrate (as N), sulphate, and hardness concentrations for low flow, average flow, and high flow conditions. The RWQM predictions provided under the 2018 Data Use Agreement did not include concentrations for cadmium, cobalt, and nickel; therefore, it was not possible to model these parameters in the Elk River at the time of model development (i.e., 2021). NWP is currently working with Teck to obtain RWQM predictions for these parameters.

The following three region Ministerial Order stations included in the RWQM are located downstream of the Project in the Elk River and Lake Koocanusa:

- EV_ER1: confluence of Elk River and Michel Creek, near Sparwood;
- RG_ELKORES: Elk River at Elko Reservoir; and
- RG_DSELK: Lake Koocanusa south of the Elk River.

Due to the different methodologies used to evaluate stream flow in the SWWQ and RWQM models, only the average flow rates and concentrations provided by the RWQM at the above three stations were considered suitable for integrating the effects from the Project into the RWQM results. During the simulation of the SWWQ model, the loading contributions from the SWWQ model to the Elk River were produced by the Project. The chemical mass and flow contributions calculated by the SWWQ were added to the adjusted water quality and stream flow of the RWQM to provide predictions of water quality and stream flow at the three stations with the inclusion of the Project to all other existing sources within the Elk Valley.

Model Scenarios and Simulations

Streamflow and water quality (i.e., the concentrations of key parameters) were calculated throughout the model domain, but specific points of interest were identified for reporting. These reporting nodes include eight in the Grave Creek and Harmer Creek watersheds, designated GC-1 (farthest downstream) to GC-8 (farthest upstream), and six in the Alexander Creek and West Alexander Creek watersheds, designated AC-1 (farthest downstream) to AC-6 (farthest upstream), in addition to the three regional RWQM nodes described above (Table 11.5-4). Of the 17 nodes modelled, 11 were carried forward in the residual effects assessment. Rationale for the exclusion of the additional six nodes includes the following:

- GC-4: Harmer Creek currently receives discharge from Teck's Elkview Operations, but no direct effect to surface water quality in Harmer Creek is anticipated as a result of Project activities.

Potential effects to Grave Creek water quality resulting from Harmer Creek will be assessed at GC-1 and GC-2;

- GC-6: Reference location upstream of the Grave Creek Reservoir, model predictions did not show any changes to surface water quality as a result of the Project at this location;
- GC-7: Runoff from the clean coal transfer area is captured in a sediment pond with discharge from this pond reporting to Grave Creek upstream of the Grave Creek Reservoir. Any potential changes to surface water quality are captured at GC-5;
- GC-8: The model predicted a slight change in surface water quality during the first year of Construction and Pre-Production (Year 0) only. During Year 0, Coal Handling Process Plant run-on and facility runoff is captured in a temporary sediment pond. Discharge from this sediment pond will join the drainage ditch adjacent to the lower haul road and discharge to Grave Creek;
- AC-4: Reference location upstream of the confluence with West Alexander Creek, model predictions did not show any changes to surface water quality as a result of the Project at this location;
- AC-5: Any change between AC-6 downstream of the Main Sediment Pond outlet and the confluence with West Alexander will be captured at AC-3 downstream of the confluence with Alexander Creek.

Table 11.5-4: Water Quality Model Reporting Nodes

Watershed	Node ID	Easting	Northing	Description
Grave Creek	GC-1	653574	15523372	Grave Creek upstream of confluence with Elk River
	GC-2	656444	15522262	Grave Creek downstream of confluence with Harmer Creek
	GC-3	656675	15522082	Grave Creek upstream of confluence with Harmer Creek
	GC-4	656768	15522311	Harmer Creek upstream of confluence with Grave Creek
	GC-5	660353	15524091	Grave Creek downstream of proposed reservoir location
	GC-6	661681	15524328	Grave Creek upstream of proposed reservoir location
	GC-7	660531	15524680	Grave Creek downstream of clean coal transfer area
	GC-8	661036	15523448	Grave Creek downstream of Coal Handling Process Plant
Alexander Creek	AC-1	663634	15502758	Alexander Creek upstream of Highway 3
	AC-2	664997	15509507	Alexander Creek mid-reach (between Highway 3 and Alexander/ West Alexander confluence)
	AC-3	664114	15515881	Alexander Creek downstream of confluence with West Alexander Creek
	AC-4	664255	15516013	Alexander Creek upstream of confluence with West Alexander Creek
	AC-5	664048	15516063	West Alexander Creek upstream of confluence with Alexander Creek
	AC-6	663438	15516813	West Alexander Creek downstream of Main Sediment Pond outlet
Elk River	EV_ER1	651397	5511103	Confluence of Elk River and Michel Creek upstream of Sparwood
	RG_ELKORES	637735	5461798	Elk River at Elko Reservoir
Lake Koocanusa	RG_DSELK	627032	5445557	Lake Koocanusa south of the Elk River

All local and regional node locations considered in the potential residual effects assessment are shown in Figure 11.5-2 and Figure 11.5-3.

The SWWQ modelling was completed under a number of conditions in order to define potential effects of the Project on the surrounding watersheds. Additionally, due to the differences in methodologies between the RWQM model and the SWWQ model climate and runoff simulations, the model was evaluated under different climate conditions for the local nodes versus the regional Elk River nodes. The SWWQ model was configured and run so that all combinations of the scenarios were simulated. This resulted in 12 simulations run in the model, as summarized in Table 11.5-5. Each of the scenarios used for the 12 simulations are described in further detail below:

1. Scenarios A and B: With Mine Components and Without Mine Components

To provide an equivalent comparison of predicted surface water quality “with mine components” versus “without mine components”, a second, parallel model was constructed that started with the same pre-mining conditions but did not simulate the development of the mine. This approach allowed an equivalent comparison of water quality at the site both with and without the Project. During all model simulations, the SWWQ calculated two scenarios simultaneously:

- A. Grave Creek and Alexander Creek watersheds remain in their relatively undisturbed condition for the entire simulation; and
- B. Mine components are dynamically simulated in the Grave Creek and Alexander Creek watersheds.

2. Scenarios 1 and 2: With Climate Change and Without Climate Change

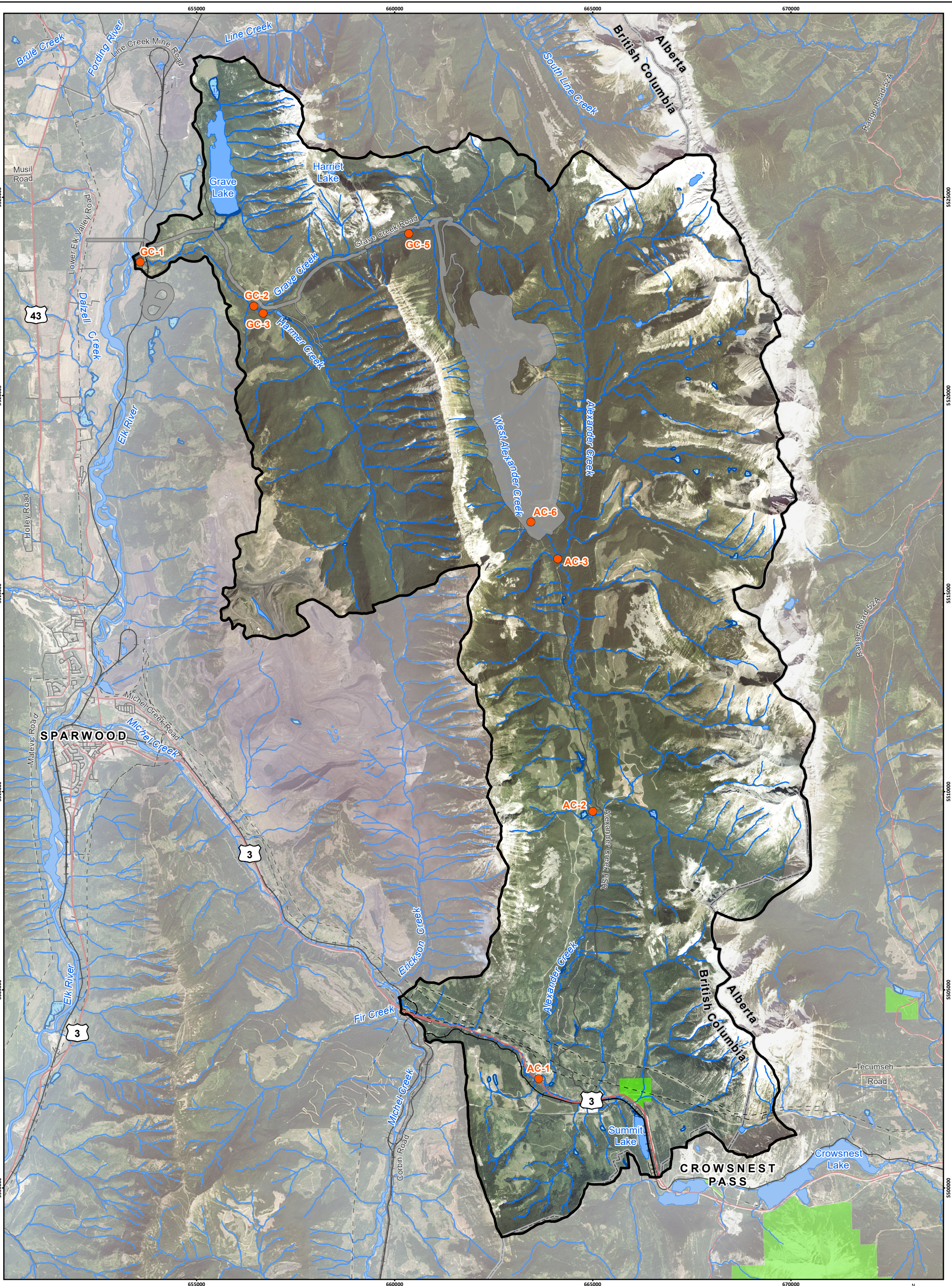
The SWWQ included the ability to simulate potential climate change impacts on the precipitation and temperature simulated in the model, which would thus impact stream flow through the runoff, snowpack accumulation, snowmelt, ice formation, and ice melt behavior simulated from precipitation and temperature inputs. The SWWQ was run for two climate change scenarios:

- 1. Climate change was not considered; and
- 2. Climate change under the RCP8.5 climate change scenarios developed from the Representative Concentration Pathway (RCP) trajectory used in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5; IPCC, 2014) was included.

3. Scenarios a, b, and c: Water Quality Predictions

The SWWQ model includes the ability to simulate different water quality source terms when introducing chemical mass into the flow network. The SWWQ model was simulated under three water quality scenarios:

- a. Source-term water quality at the 50th percentile values (i.e., average values) and assume the Mine Rock Storage Facility approach functions as intended;
- b. Source-term water quality at the 95th percentile values (i.e., upper values) and assume the Mine Rock Storage Facility approach functions as intended; and
- c. Source-term water quality at the 95th percentile values (i.e., upper values), assuming the Mine Rock Storage Facility approach does not function as intended and seepage from the Mine Rock Storage Facility is similar to that of a conventional mine rock storage facility with no treatment.

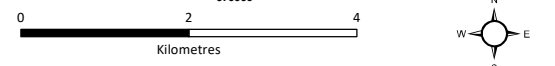


Crown Mountain Coking Coal Project

Figure 11.5-2
Aquatic Local Study Area Water Quality Nodes

LEGEND

- | | |
|---|---|
| ● Water Quality Node | Waterbody |
| Aquatic Local Study Area | Wetland |
| Project Footprint | Provincial Park/Protected Area |
| Highway | British Columbia/Alberta Border |
| Arterial/Collector Road | Local/Resource Road |
| Railway | Transmission Line |
| Transmission Line | Watercourse |



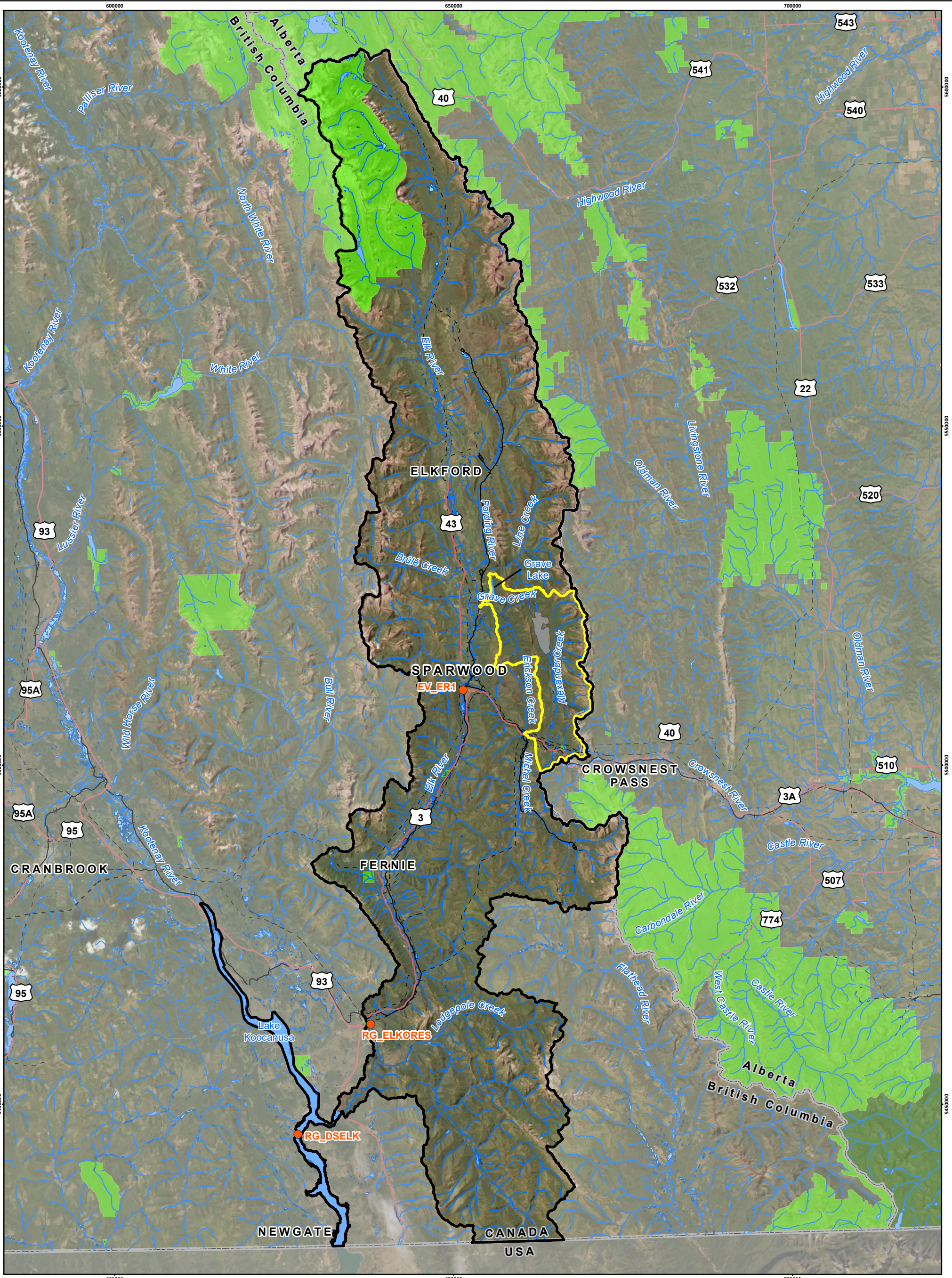
Scale 1:90,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada. Imagery Provided By Landsat 8 (Aug 2018), and GeoBC Ortho Imagery (Aug 2016).

Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2021-02-24

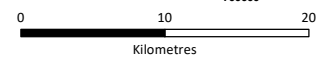


Crown Mountain Coking Coal Project

Figure 11.5-3
Aquatic Regional Study Area Water Quality Nodes

LEGEND

- Water Quality Node
- Aquatic Regional Study Area
- Aquatic Local Study Area
- Project Footprint
- Highway
- +— Railway
- - - Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/ Alberta Border



Scale 1:525,000

Map Drawing Information:
Data Provided by NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeBC Open Data, Government of Alberta Open Data, Natural Resource Canada, Elk Valley Water Quality Plan.
Imagery Provided by ESRI.

Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2021-02-24

Table 11.5-5: Site Wide Water Quality Model Simulations

Simulation ID	Mine Components	Climate Change	Source Term	Mine Rock Storage Facility Approach
A.1.a	Not Present	No Climate Change	50 th percentile	N/A
A.1.b	Not Present	No Climate Change	95 th percentile	N/A
A.1.c	Not Present	No Climate Change	95 th percentile	N/A
A.2.a	Not Present	With Climate Change	50 th percentile	N/A
A.2.b	Not Present	With Climate Change	95 th percentile	N/A
A.2.c	Not Present	With Climate Change	95 th percentile	N/A
B.1.a	Present	No Climate Change	50 th percentile	Successful
B.1.b	Present	No Climate Change	95 th percentile	Successful
B.1.c	Present	No Climate Change	95 th percentile	Fails
B.2.a	Present	With Climate Change	50 th percentile	Successful
B.2.b	Present	With Climate Change	95 th percentile	Successful
B.2.c	Present	With Climate Change	95 th percentile	Fails

Assumptions and Limitations

The water and load balance model is based on a series of expected and conservative assumptions developed to be representative of the water and chemical mass conditions observed at the current, undeveloped site or conditions expected during future development of the Project. The water and load balance by necessity includes the simplification of a number of complex natural phenomena, including, but not limited to climate, runoff, snow melt, ice formation, infiltration, and seepage attenuation. The model uses physical models that are only representations of these processes and are calibrated to observed baseline data, where possible. However, many of these processes do not exist in the current, undeveloped conditions and as such future behaviour cannot be predicted with precision.

Water quality inputs to the model were developed from geochemical and hydraulic modelling and are based on a limited number of samples of a large mass of rock that will ultimately produce the impacted runoff and seepage flows. The model explores the possible range of water quality expected in the Project through the use of both average and upper case water quality inputs, but it must be stressed that they are only estimations of the water quality that will potentially occur during the Project lifespan.

A key aspect of the surface water modelling is the integration of the SWWQ model and the RWQM. The RWQM was developed separately from the SWWQ model and uses different approximations of physical models, methodologies, and time scales. Integrating these two models was performed using average values to provide the best alignment and thus is unable to capture the extreme events that may be experienced in the future by either model.

Understanding that the model is an estimation of the actual behaviour that will potentially occur in the future, observed behaviour of physical processes and the system as the Project is developed will be compared with the modelling results to refine the model, physical processes, and inputs to improve the model performance.

Screening of Contaminants of Potential Concern

Due to the large number of potential results (12 scenarios, 17 reporting nodes, and 43 chemical parameters), an initial screening analysis was conducted to determine which chemical parameters were of potential concern. A screening threshold level was established for each parameter based on current provincial and federal guidelines (Table 11.5-6). Where available, the B.C. long-term chronic WQG for the protection of freshwater aquatic life was used as the screening threshold. Where such guidelines did not exist, CCME CWQG for the protection of freshwater aquatic life, followed by B.C. or CCME guidelines for agriculture, irrigation, recreation, and drinking water quality were used. Parameters without established guidelines were not screened or considered further in the assessment.

For the 12 scenarios at each node, an exceedance count was calculated for three different levels (50%, 75%, and 100% of the lowest applicable guideline). The number of days that the simulated water quality exceeded the threshold of 50%, 75%, or 100% of the base threshold level was recorded, resulting in a value between 0 and 12,418 (total number of days in the simulation), which was presented as the percent of the simulated days that the predicted water quality exceeded the associated threshold. The results of the screening analysis at each of the 11 reporting nodes for each simulation scenario are provided in SRK (2021e); Appendix 10-A). The results of the screening analyses were used to focus the assessment moving forward, and reduced the number of contaminants of potential concern from 43 to the following 6 parameters:

- Cobalt (Co) – selected based on guideline exceedances during the screening process;
- Cadmium (Cd) – selected based on guideline exceedances during the screening process and because it is an Order constituent in the EVWQP (Teck, 2014);
- Nickel (Ni) – selected because it was identified as a parameter of potential concern in the Elk Valley by the Ktunaxa Nation Council;
- Nitrate (NO₃) – selected because it is an Order constituent under the EVWQP (Teck, 2014);
- Selenium (Se) – selected based on guideline exceedances during the screening process and because it is an Order constituent in the EVWQP (Teck, 2014); and
- Sulphate (SO₄) – selected because it is an Order constituent under the EVWQP (Teck, 2014).

11.5.4.2 Potential Residual Effects Assessment

Daily simulated water quality results were produced for each of the 12 scenarios and 11 nodes described above. For the purposes of the effects assessment, two scenarios were selected as a conservative approach through which potential residual effects on water quality were assessed at the 11 reporting nodes:

- Scenario B.1.a (mine present, no climate change, 50th percentile [average/expected case] results, Mine Rock Storage Facility layering design is successful); and
- Scenario B.1.b (mine present, no climate change, 95th percentile [upper case] results, Mine Rock Storage Facility layering design is successful).

For comparison to existing water quality, the 50th and 95th percentile source term background water quality values (Scenarios A.1.a and A.1.b) are also presented. Scenarios that include climate change projections (i.e., A.2.a, A.2.b, A.2.C; B.2.a; B.2.b; B.2.c) are not considered further in the potential residual effects assessment; instead, climate change impacts to surface water quality are discussed in the cumulative effects assessment in Section 11.6. The residual effects assessment assumes that the Mine

Table 11.5-6: Screening Threshold Levels

Parameter	Threshold Value (mg/L)	Type	Source	Notes
Alkalinity	≥ 20	Long-term chronic	B.C. Working WQG	Assuming calcium concentration > 20 mg/L
Hardness	-	-	-	Not screened
Silver (Ag)	0.00005	Long-term chronic	B.C. WQG	-
Aluminum (Al)	0.1	Not specified	CCME CWQG	Assuming pH > 6.5
Arsenic (As)	0.005	Short-term acute	B.C. WQG	No long-term chronic guideline available
Boron (B)	1.2	Long-term chronic	B.C. WQG	-
Barium (Ba)	1	Long-term chronic	B.C. Working WQG	-
Beryllium (Be)	0.00013	Long-term chronic	B.C. Working WQG	-
Bismuth (Bi)	-	-	-	Not screened
Calcium (Ca)	1000	Long-term chronic	CCME CWQG for the Protection of Agriculture	Irrigation/livestock guideline
Cadmium (Cd)	0.0002115	Long-term chronic	B.C. WQG	-
Chloride (Cl)	150	Long-term chronic	B.C. WQG	-
Cobalt (Co)	0.004	Long-term chronic	B.C. WQG	-
Chromium (Cr)	0.001	Long-term chronic	B.C. WQG	For chromium VI (hexavalent)
Copper (Cu)	0.0020	Long-term chronic	B.C. WQG	-
Fluorine (F)	1.33	Short-term acute	B.C. Interim WQG	-
Iron (Fe)	0.3	Long-term chronic	CCME CWQG	Federal guideline used as conservative measure
Mercury (Hg)	0.00002	Long-term chronic	B.C. WQG	-
Potassium (K)	-	-	-	Not screened
Lithium (Li)	0.87	-	B.C. Working WQG (2017)	-
Magnesium (Mg)	-	-	-	Not screened
Manganese (Mn)	0.00105	Long-term chronic	B.C. WQG	-
Molybdenum (Mo)	0.073	Long-term chronic	CCME Interim CWQG	Federal guideline used as conservative measure
Sodium (Na)	200	-	Schedule 3.2, B.C. Contaminated Sites Regulation 375/96	Drinking water standard
Ammonia (NH ₃)	0.61	Long-term chronic	B.C. WQG	Assuming annual average site-wide baseline temperature of 4°C and pH 8.3
Nickel (Ni)	0.096	Long-term chronic	B.C. Working WQG	-
Nitrite (NO ₂)	0.02	Long-term chronic	B.C. WQG	Assuming chloride concentration < 2 mg/L
Nitrate (NO ₃)	3	Long-term chronic	B.C. Interim WQG	-

Parameter	Threshold Value (mg/L)	Type	Source	Notes
Phosphorus (P)	0.01	Primary contact	B.C. Recreational WQG	Guideline for recreational and aesthetic purposes
Lead (Pb)	0.00318	Long-term chronic	CCME CWQG	Federal guideline used as conservative measure
Sulphur (S)	-	-	-	Not screened
Antimony (Sb)	0.009	Long-term chronic	B.C. Working WQG	For antimony (III)
Selenium (Se)	0.002	Long-term chronic	B.C. WQG	-
Silicon (Si)	-	-	-	Not screened
Tin (Sn)	-	-	-	Not screened
Sulphate (SO ₄)	310	Long-term chronic	B.C. WQG	-
Strontium (Sr)	7	Maximum acceptable concentration	B.C. Source Drinking Water Quality Guidelines	-
Titanium (Ti)	1	-	Schedule 3.2, B.C. Contaminated Sites Regulation 375/96	Aquatic life standard
Thallium (Tl)	0.0008	Long-term chronic	B.C. Working WQG	-
Uranium (U)	0.0085	Long-term chronic	B.C. Working WQG	-
Vanadium (V)	0.1	Long-term chronic	CCME CWQG for the Protection of Agriculture	Irrigation/livestock guideline
Zinc (Zn)	0.015	Long-term chronic	B.C. WQG Acute	-
Zirconium (Zr)	-	-	-	Not screened

Note: A conservative hardness of 100 mg/L as CaCO₃ was selected for the initial screening for parameters with hardness-dependent guidelines.

Rock Storage Facility functions in the manner in which it was designed; consequently Scenarios B.1.b and B.2.c (layering approach fails) are not considered further in this assessment. The predicted water quality results under all 12 scenarios are available in Appendix 10-A. Site-specific uncertainties as it relates to the emerging mitigation measures such as the proposed Mine Rock Storage Facility will be addressed in a Technology Maturation Plan before implementation. The Technology Maturation Plan will be completed as part of the TRA for the JAIR. An initial review of the Water Mitigation Technology Readiness (Maven Water & Environment and Integrated Sustainability, 2023) can be found in Appendix 11-E.

As discussed in Section 11.5.4, the residual effects from surface-groundwater interactions, the disposal of the mine rock/coal rejects, and the sediment pond discharge were assessed simultaneously using the SWWQ model, and as such, this analysis addresses all three residual effects. The following subsections describe the monthly median predicted water quality for each of the six contaminants of potential concern within each local and regional watercourse assessed. For hardness-dependent water quality guidelines, annual median hardness concentrations were used for each site. Tabulated results for each contaminant of potential concern are presented in Appendix 11-G. Geochemical charts for selenium, nitrate, sulphate, cadmium, cobalt, and nickel concentrations in the Interim and Main Sediment Pond effluent are provided in Appendix 11-H.

A high-level summary of parameters that exceed the B.C. WQG at the local and regional water quality reporting nodes during one or more Project phases is presented in Table 11.5-7.

11.5.4.2.1 Results – Grave Creek

Although no potential Project-related residual effects to surface water quality are anticipated in Grave Creek as discussed in Section 11.5.2, predicted water quality results for the six contaminants of potential concern (i.e., cadmium, cobalt, nickel, nitrate, selenium, and sulphate) are presented at the following four locations (i.e., prediction nodes) in Grave Creek to support this conclusion (Figure 11.5-2):

- GC-5, downstream of the Grave Creek Reservoir;
- GC-3, upstream of the Confluence with Harmer Creek;
- GC-2, downstream of the confluence with Harmer Creek; and
- GC-1, upstream of the confluence with the Elk River.

Cadmium

Median cadmium concentrations for both Scenario B.1.a and B.1.b (hereafter referred to as the 50th and 95th percentile scenarios, respectively) in upper Grave Creek are predicted to remain below the hardness-dependent long-term chronic B.C. WQG throughout all phases of the Project and show minimal deviation from background levels downstream of the Grave Creek Reservoir at prediction node GC-5 and upstream of the confluence with Harmer Creek (GC-3; Figure 11.5-4 and Figure 11.5-5).

Downstream of the confluence with Harmer Creek at nodes GC-2 and GC-1, cadmium concentrations for both the 50th and 95th percentile scenarios are predicted to remain below the long-term chronic B.C. WQG (Figure 11.5-6 and Figure 11.5-7), although the concentrations are approximately twice that of upstream of Harmer Creek. Given current operating mines in the Elk Valley, this increase in concentration is likely attributable to discharge from Teck's Elkview Operations into Harmer Creek upstream of the confluence with Grave Creek, and therefore does not occur as a result of Project activities.

Table 11.5-7: Summary of Predicted B.C. Water Quality Guideline Exceedances at Local and Regional Water Quality Nodes

Parameter	Scenario	Grave Creek				West Alexander Creek	Alexander Creek			Elk River		Lake Kocanusa
		GC-1	GC-2	GC-3	GC-5	AC-6	AC-1	AC-2	AC-3	EV_ER1	RG_ELKORES	RG_DSELK
Cadmium	B.1.a (50 th Percentile)	-	-	-	-	Operations, Reclamation and Closure, Post-Closure	-	-	-	N/A	N/A	N/A
	B.1.b (95 th Percentile)	-	-	-	-	Operations, Reclamation and Closure, Post-Closure	-	-	-	N/A	N/A	N/A
Cobalt	B.1.a (50 th Percentile)	-	-	-	-	Operations, Reclamation and Closure, Post-Closure	-	-	-	N/A	N/A	N/A
	B.1.b (95 th Percentile)	-	-	-	-	Operations, Reclamation and Closure, Post-Closure	-	-	Operations, Reclamation and Closure, Post-Closure	N/A	N/A	N/A
Nickel	B.1.a (50 th Percentile)	-	-	-	-	-	-	-	-	N/A	N/A	N/A
	B.1.b (95 th Percentile)	-	-	-	-	-	-	-	-	N/A	N/A	N/A
Nitrate	B.1.a (50 th Percentile)	-	-	-	-	-	-	-	-	-	-	-
	B.1.b (95 th Percentile)	-	-	-	-	-	-	-	-	-	-	-
Selenium	B.1.a (50 th Percentile)	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	-	-	Operations, Reclamation and Closure, Post-Closure	-	-	-	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production
	B.1.b (95 th Percentile)	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	-	-	Operations, Reclamation and Closure, Post-Closure	Operations, Reclamation and Closure, Post-Closure	Operations, Reclamation and Closure, Post-Closure	Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production, Operations, Reclamation and Closure, Post-Closure	Construction and Pre-Production
Sulphate	B.1.a (50 th Percentile)	-	-	-	-	-	-	-	-	-	-	-
	B.1.b (95 th Percentile)	-	-	-	-	-	-	-	-	-	-	-

Note:
N/A = parameter not modelled

Cobalt

Median cobalt concentrations in upper Grave Creek for both the 50th and 95th percentile scenarios are predicted to remain below the long-term chronic B.C. WQG of 0.004 mg/L throughout all phases of the Project and show minimal change from background levels in the section of creek downstream of the Grave Creek Reservoir at prediction node GC-5 and upstream of the confluence with Harmer Creek (GC-3; Figure 11.5-4 and Figure 11.5-5).

Downstream of the confluence with Harmer Creek at prediction nodes GC-2 and GC-1, cobalt concentrations for both the 50th and 95th percentile scenarios are expected to remain below the long-term chronic B.C. WQG (Figure 11.5-6 and Figure 11.5-7), although the concentrations are approximately twice that of upstream of Harmer Creek. Similar to other parameters, this increase in concentration is likely attributable to discharge from Teck's Elkview Operations into Harmer Creek upstream of the confluence with Grave Creek, and therefore does not occur as a result of Project activities.

Nickel

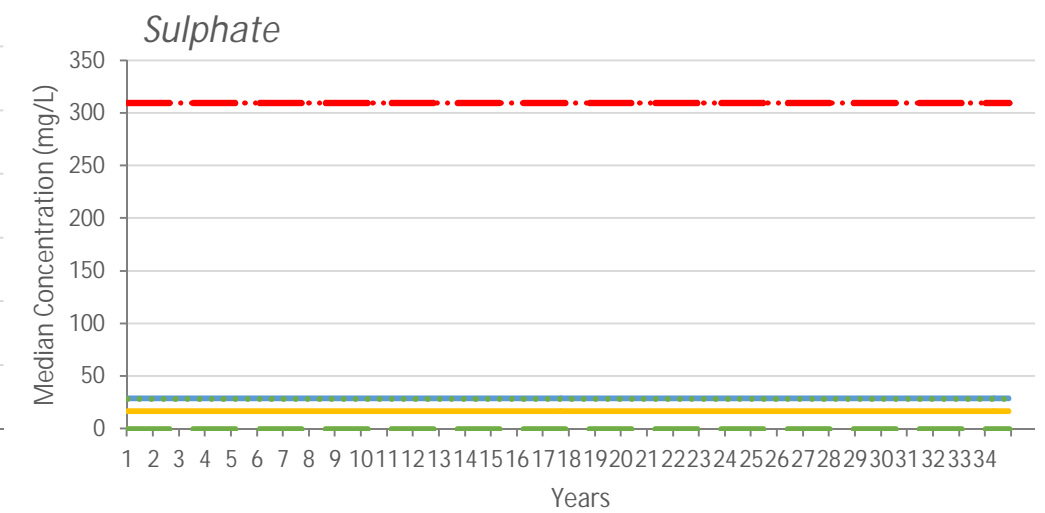
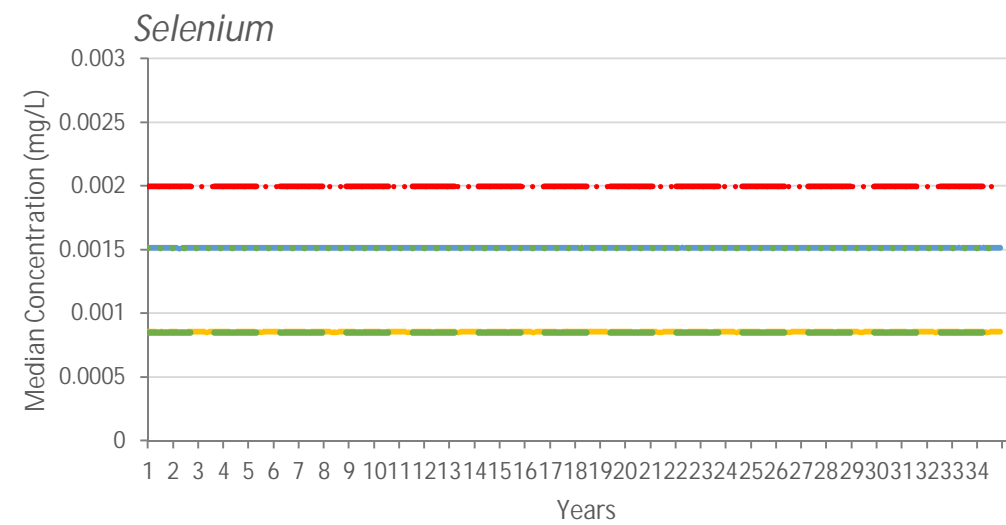
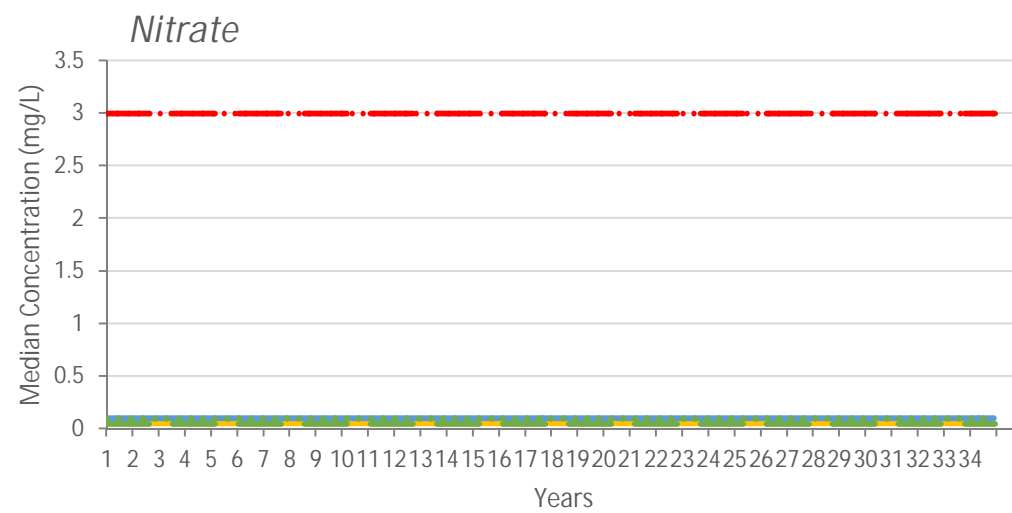
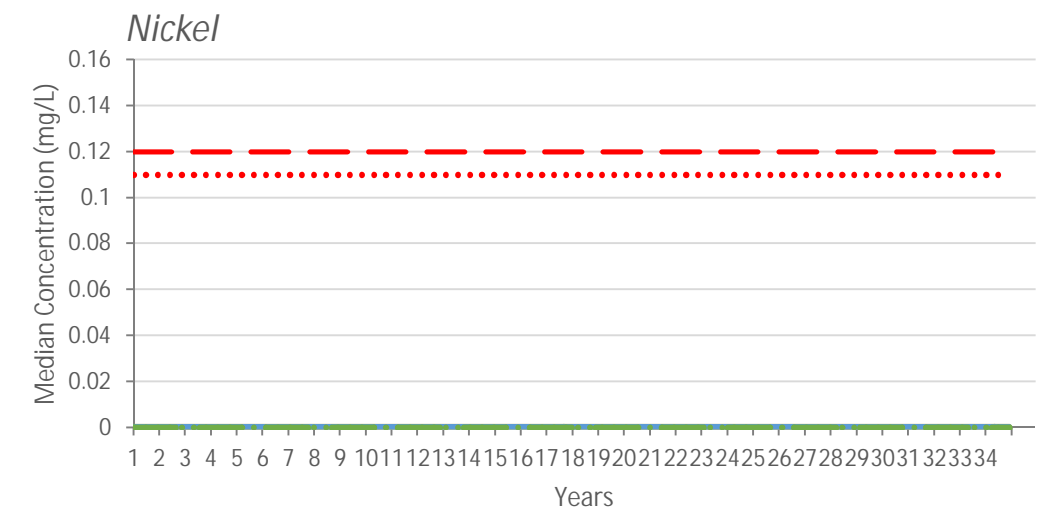
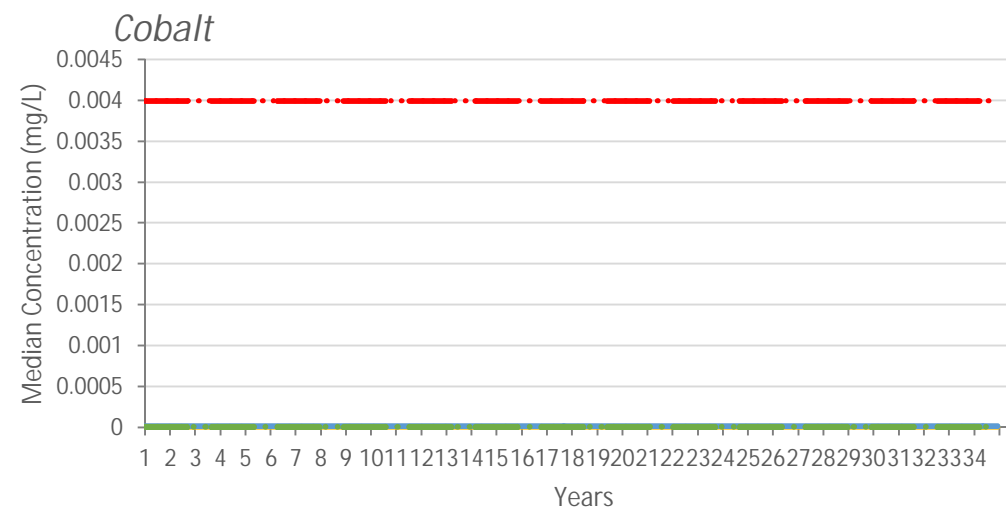
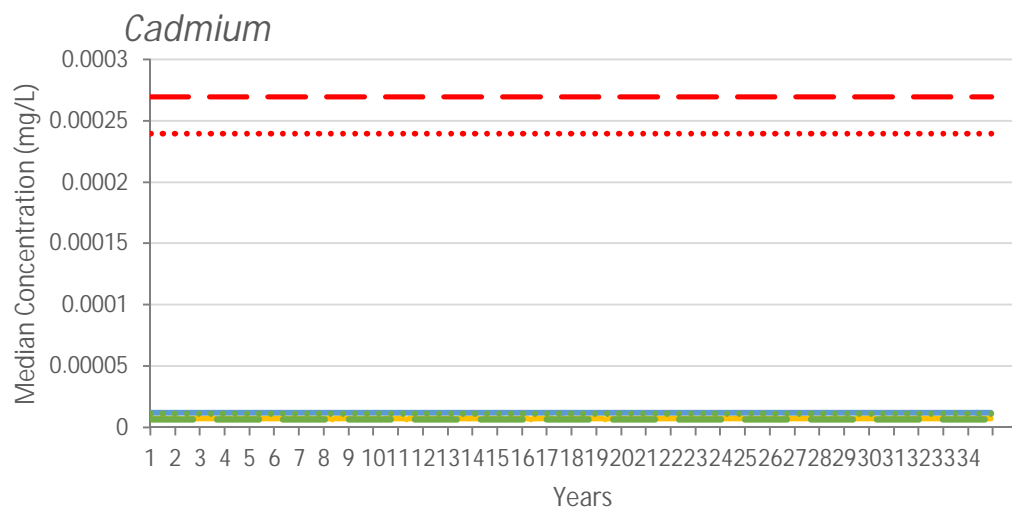
Median nickel concentrations in upper Grave Creek for both the 50th and 95th percentile scenarios are predicted to remain below the hardness-dependent long-term chronic B.C. WQG throughout all phases of the Project and show minimal change from background levels in the section of creek downstream of the Grave Creek Reservoir at prediction node GC-5 and upstream of the confluence with Harmer Creek (GC-3; Figure 11.5-4 and Figure 11.5-5).

Downstream of the confluence with Harmer Creek at prediction nodes GC-2 and GC-1, nickel concentrations for both the 50th and 95th percentile scenarios are expected to remain below the long-term chronic B.C. WQG (Figure 11.5-6 and Figure 11.5-7), and do not show an increase in concentration relative to upstream concentrations.

Nitrate

Median nitrate concentrations in upper Grave Creek for both the 50th and 95th percentile scenarios are predicted to remain below the long-term chronic B.C. WQG of 3 mg/L throughout all phases of the Project and show minimal change from background levels in the section of creek downstream of the Grave Creek Reservoir at prediction node GC-5 and upstream of the confluence with Harmer Creek (GC-3; Figure 11.5-4 and Figure 11.5-5).

Downstream of the confluence with Harmer Creek at prediction nodes GC-2 and GC-1, nitrate concentrations for both the 50th and 95th percentile scenarios are expected to remain below the long-term chronic B.C. WQG (Figure 11.5-6 and Figure 11.5-7), although the concentrations are approximately twice that of upstream of Harmer Creek. Given current operating mines in the Elk Valley, this increase in concentration is likely attributable to discharge from Teck's Elkview Operations into Harmer Creek upstream of the confluence with Grave Creek, and therefore does not occur as a result of Project activities.



- Median Predicted Concentration (50th Percentile)
- Median Predicted Concentration (95th Percentile)
- ⋯ BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (50th Percentile)
- - - BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (95th Percentile)
- 50th Percentile Source Term Background Water Quality
- ⋯ 95th Percentile Source Term Background Water Quality

Figure 11.5-4: Water Quality Predictions for Grave Creek Node GC-5

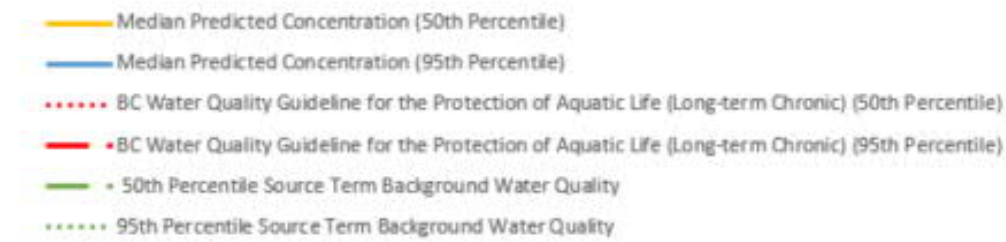
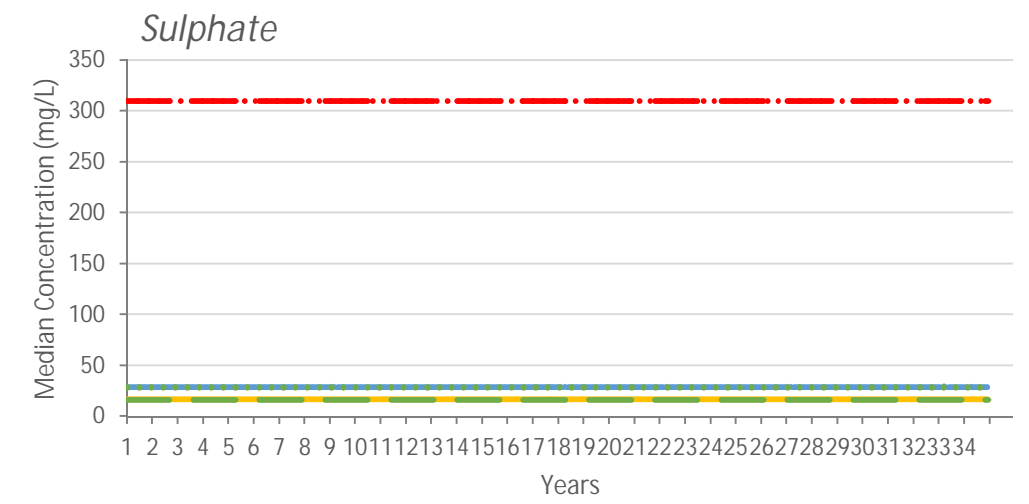
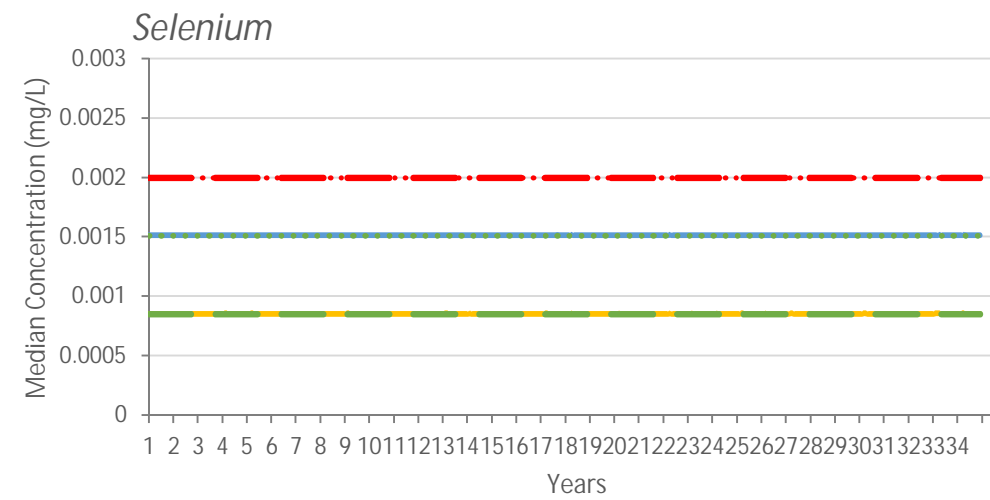
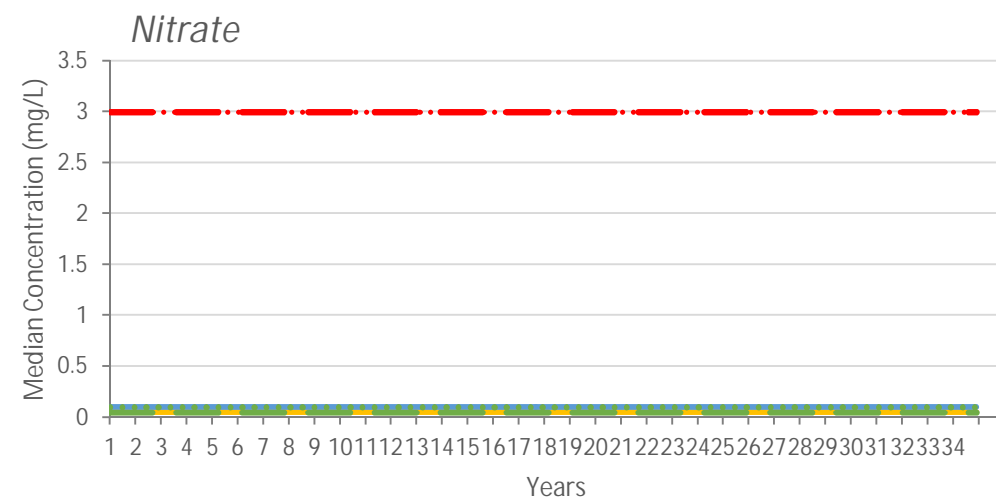
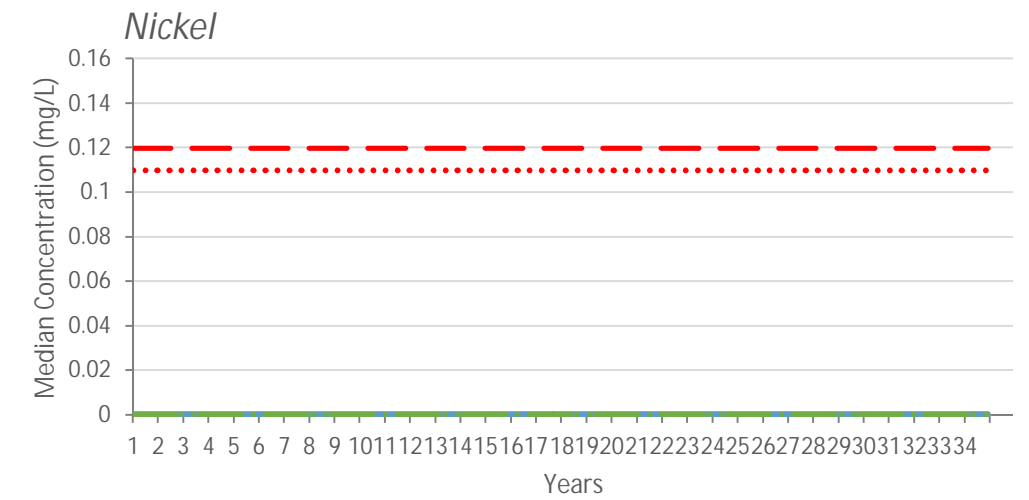
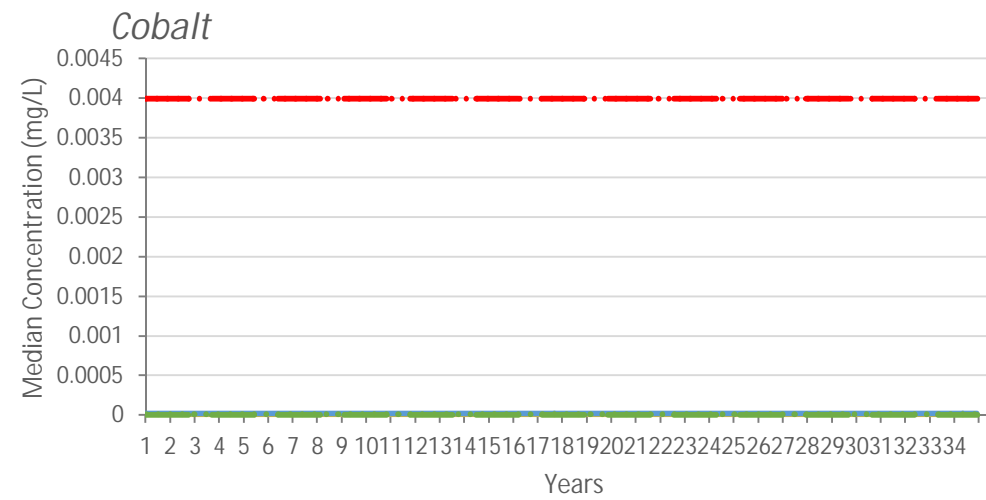
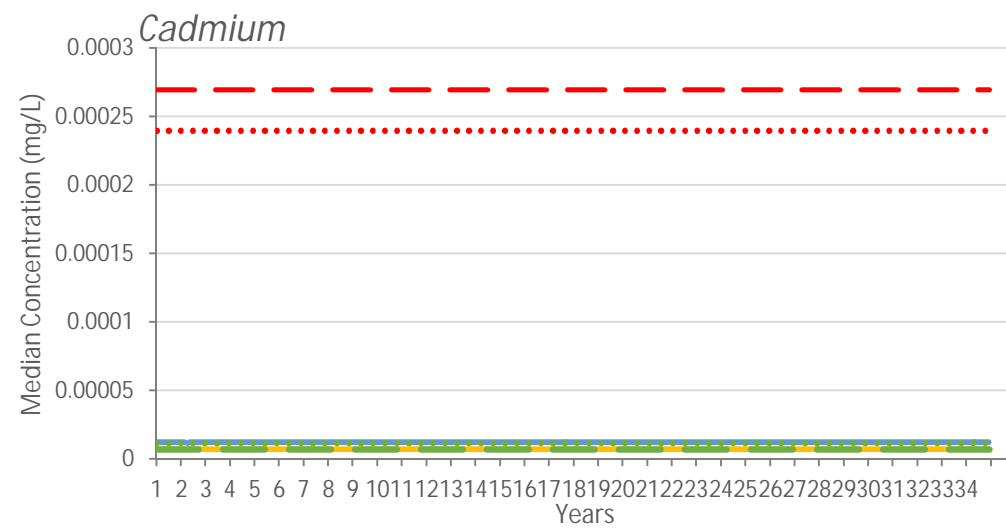


Figure 11.5-5: Water Quality Predictions for Grave Creek Node GC-3

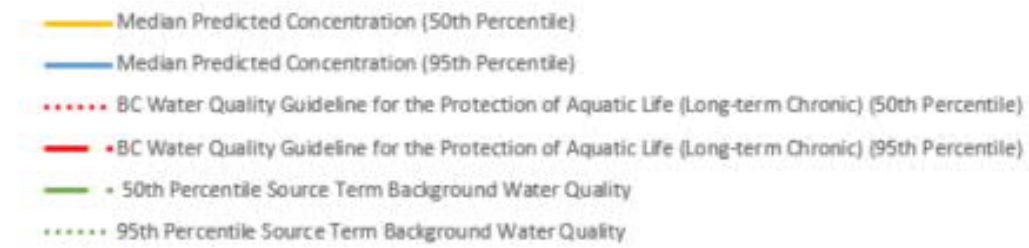
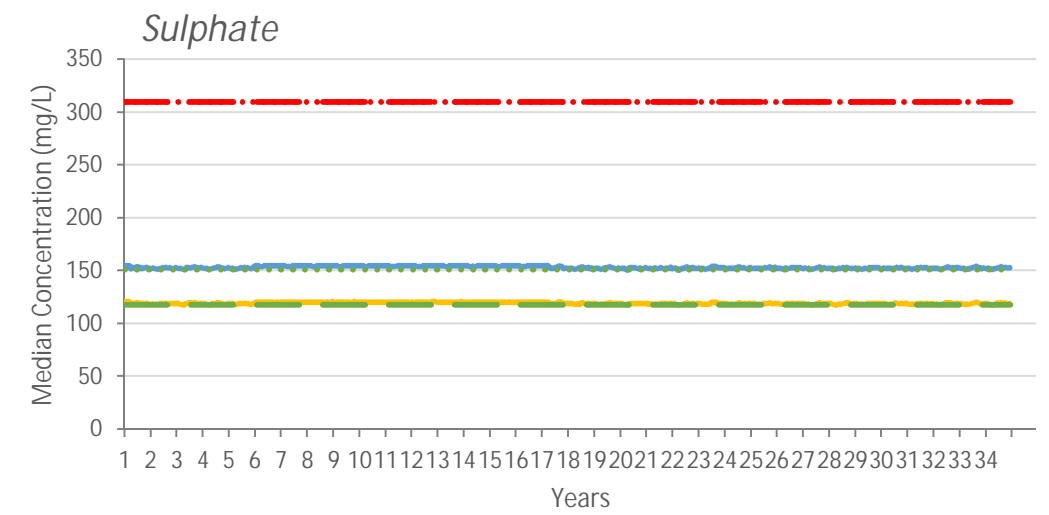
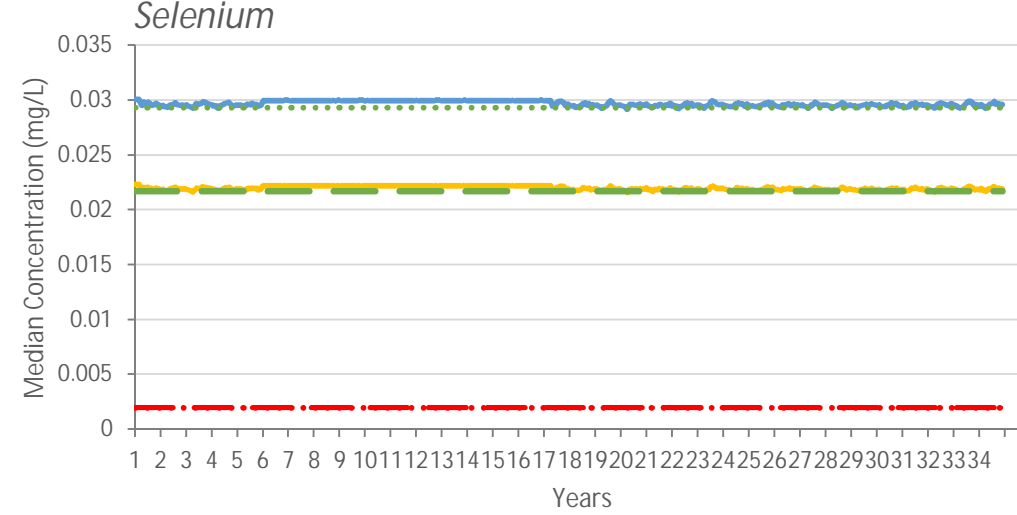
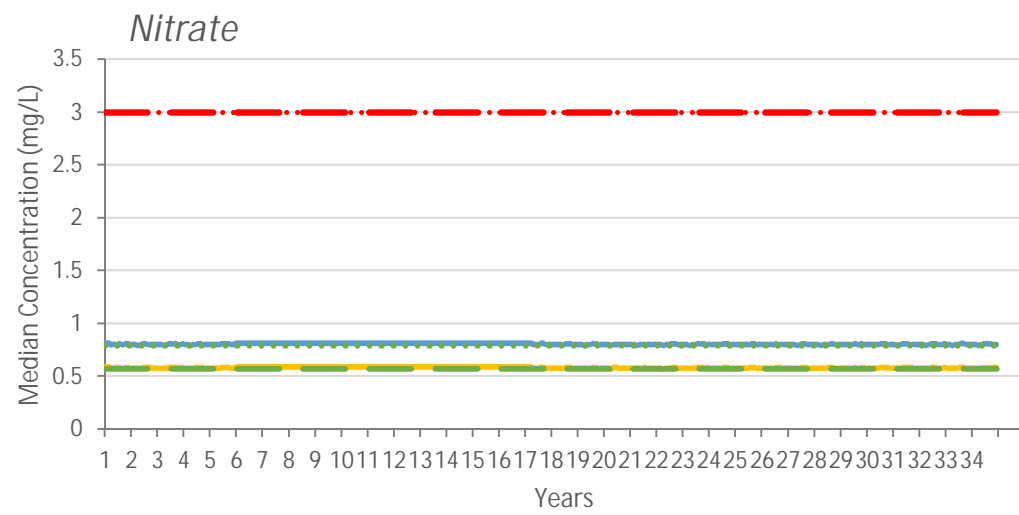
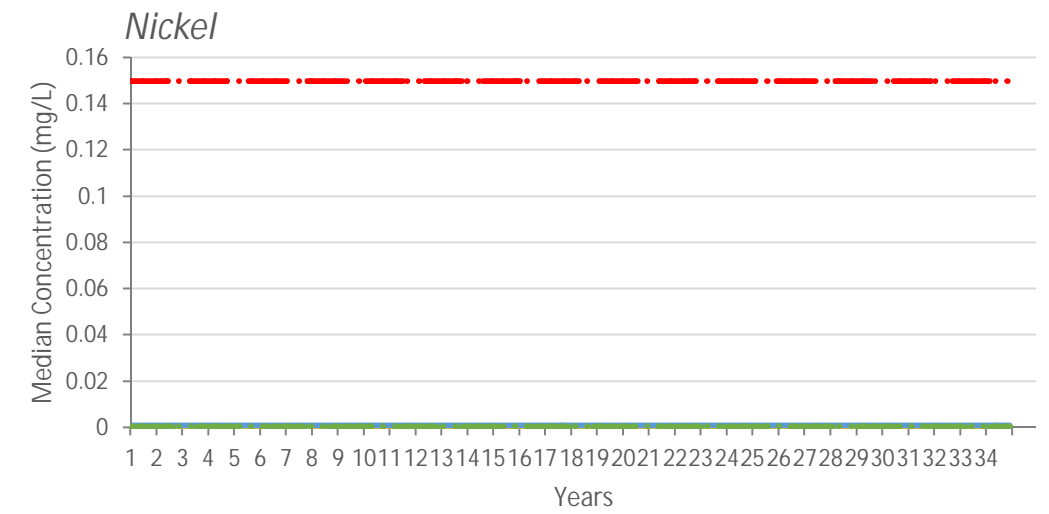
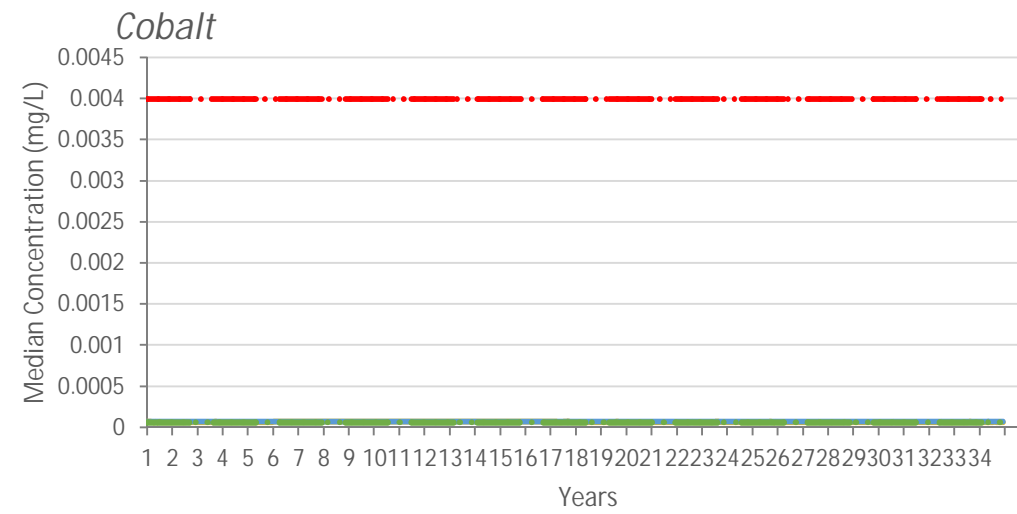
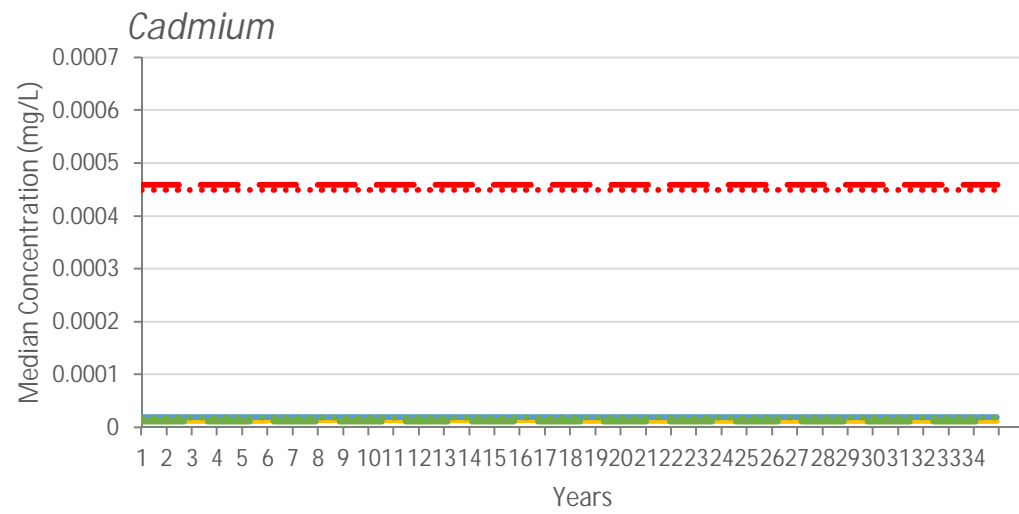


Figure 11.5-6: Water Quality Predictions for Grave Creek Node GC-2

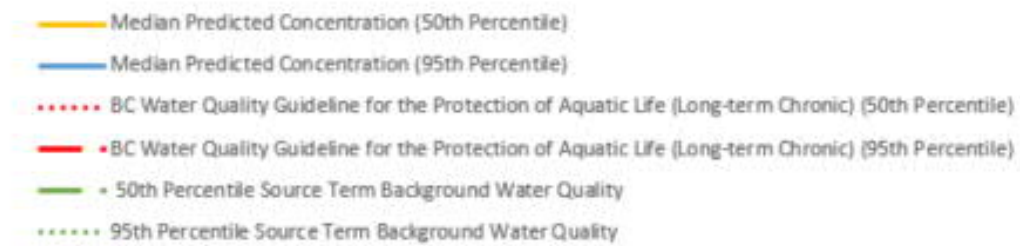
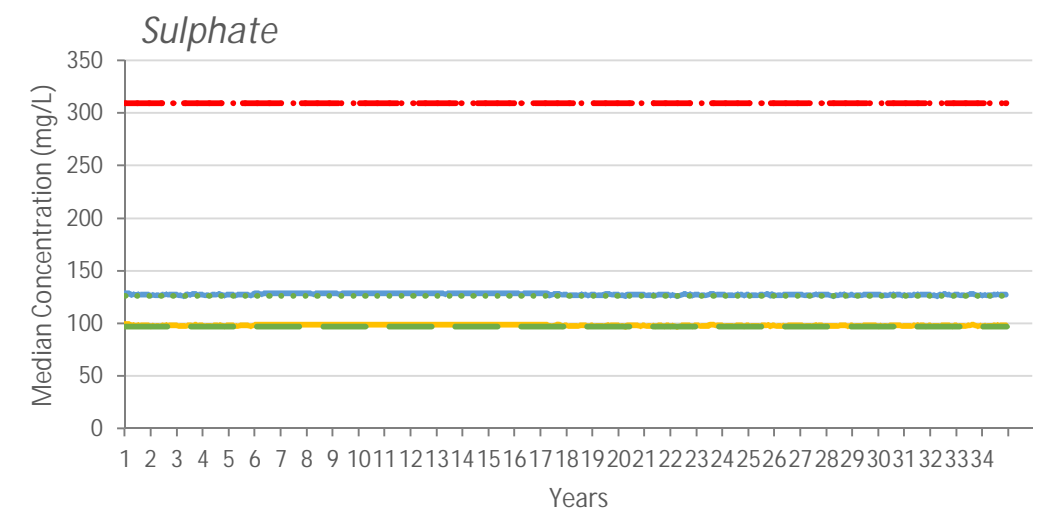
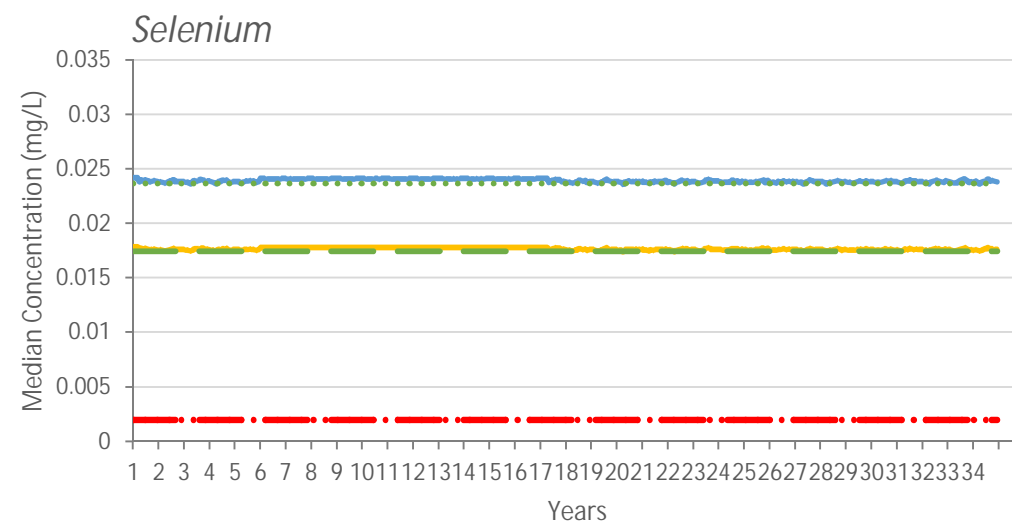
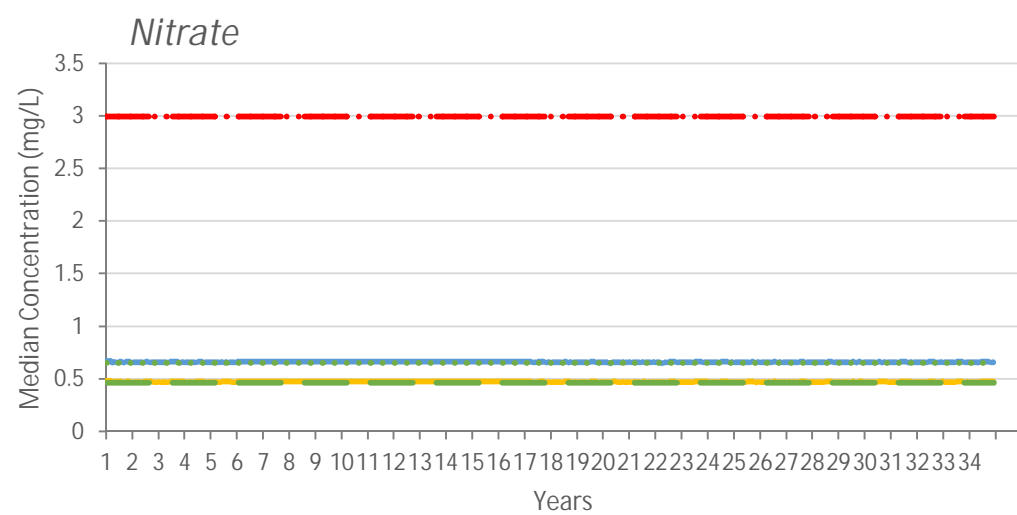
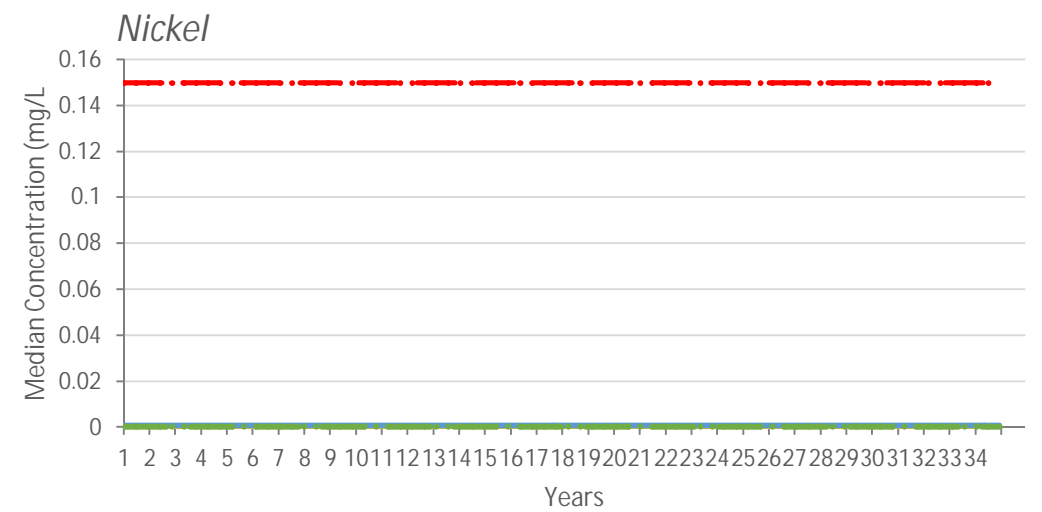
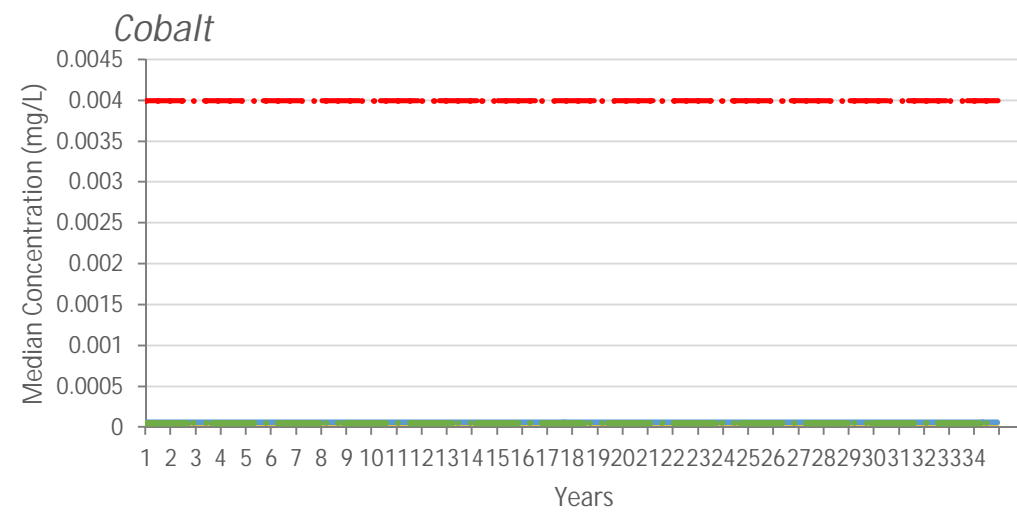
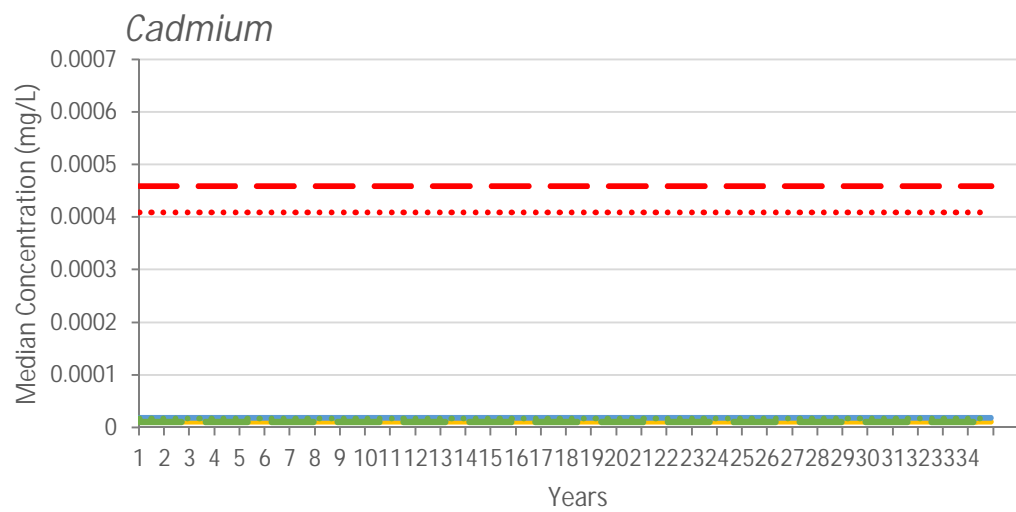


Figure 11.5-7: Water Quality Predictions for Grave Creek Node GC-1

Selenium

Median selenium concentrations in upper Grave Creek for both the 50th and 95th percentile scenarios are predicted to remain below the long-term chronic B.C. WQG of 0.002 mg/L throughout all phases of the Project and show minimal change from background levels in the section of creek downstream of the Grave Creek Reservoir at prediction node GC-5 and upstream of the confluence with Harmer Creek (GC-3 Figure 11.5-4 and Figure 11.5-5).

Downstream of the confluence with Harmer Creek at prediction nodes GC-2 and GC-1, selenium concentrations for both the 50th and 95th percentile scenarios slightly exceed the long-term chronic B.C. WQG (Figure 11.5-6 and Figure 11.5-7). Given current operating mines in the Elk Valley, this increase in concentration is likely attributable to discharge from Teck's Elkview Operations into Harmer Creek upstream of the confluence with Grave Creek, and therefore does not occur as a result of Project activities.

Sulphate

Median sulphate concentrations in upper Grave Creek for both the 50th and 95th percentile scenarios are predicted to remain below the long-term chronic B.C. WQG of 309 mg/L throughout all phases of the Project, and show minimal change from background levels in the stretch of creek downstream of the Grave Creek Reservoir at prediction node GC-5 and upstream of the confluence with Harmer Creek (GC-3; Figure 11.5-4 and Figure 11.5-5).

Downstream of the confluence with Harmer Creek at prediction nodes GC-2 and GC-1, sulphate concentrations for both the 50th and 95th percentile scenarios are predicted to remain below the long-term chronic B.C. WQG (Figure 11.5-6 and Figure 11.5-7), although the concentrations are approximately 1.5 times greater than concentrations in Grave Creek upstream of Harmer Creek. Given current operating mines in the Elk Valley, this increase in concentration is likely attributable to discharge from Teck's Elkview Operations into Harmer Creek upstream of the confluence with Grave Creek, and therefore does not occur as a result of Project activities.

11.5.4.2.2 Results – West Alexander Creek

Water quality predictions in West Alexander Creek were assessed at node AC-6 immediately downstream of the sediment pond discharge (Figure 11.5-2). Similar trends were observed for each of the parameters evaluated and are described in detail in the following subsections.

Cadmium

Median cadmium concentrations in West Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain similar to background water quality for the first 5 years of Pre-Production and Operations, with a rapid increase in concentration to approximately 20 times the background concentration after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-8).

Cadmium concentrations in West Alexander Creek are predicted to remain below the hardness-dependent B.C. WQG until Year 7 in the 95th percentile scenario, with guideline exceedances occurring every winter from Years 8 to 34. No exceedances occur in the 50th percentile results until Year 13 of the Project (i.e., the 11th year of Operations). Maximum concentrations reach 0.00063 mg/L in Year 17 (final year of Operations) in the 95th percentile case, and 0.00042 mg/L in Year 17 in the 50th percentile case.

Cadmium concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. Concentrations well below the guideline values occur between freshet and late summer/early fall every year in both scenarios.

Cobalt

Median cobalt concentrations in West Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain similar to background water quality for the first 5 years of Pre-Production and Operations, with a rapid increase in concentration to approximately 30 times the background concentration after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-8). Cobalt concentrations are predicted to increase above the B.C. WQG of 0.004 mg/L from Year 6 until Year 34 in the 95th percentile scenario, with guideline exceedances occurring every winter from Years 8 to 34. No exceedances occur in the 50th percentile scenario until Year 13 of the Project (i.e., the 11th year of Operations). Maximum concentrations reach 0.033 mg/L in Year 17 in the 95th percentile scenario, and 0.00083 mg/L in Year 17 in the 50th percentile scenario. Cobalt concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. Concentrations well below the guideline values occur between freshet and late summer/early fall every year in the 50th percentile scenario, but primarily remain elevated above guideline value year round in the 95th percentile scenario.

Nickel

Median nickel concentrations in West Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain similar to background for the first 5 years of Pre-Production and Operations, with a rapid increase in concentration by approximately 30-40 times background concentration after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-8). While nickel concentrations steadily increase until concentrations level off after Year 17 of the Project, they are predicted to remain below the hardness-dependent B.C. WQG throughout the Project in both the 50th and 95th percentile scenarios. Nickel concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet.

Nitrate

Median nitrate concentrations in West Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain similar to background water quality for the first 5 years of Pre-Production and Operations, and increase in concentration by approximately 50% after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-8). Nitrate concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. However, nitrate concentrations are predicted to remain well below the B.C. WQG of 3 mg/L throughout the Project in both the 50th and 95th percentile scenarios.

Selenium

Median selenium concentrations in West Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain similar to background water quality for the first 5 years of Pre-Production and Operations, with a rapid increase to approximately 4 times the background concentration after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-8).

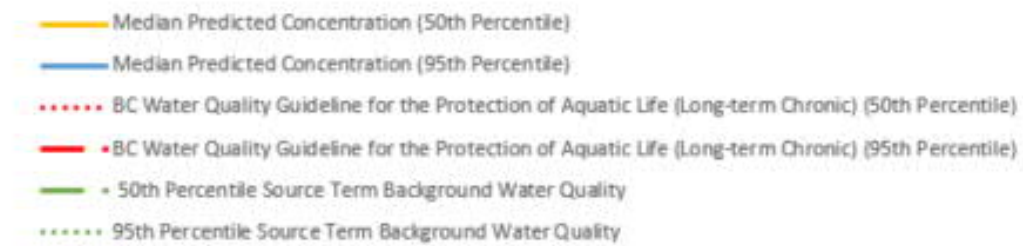
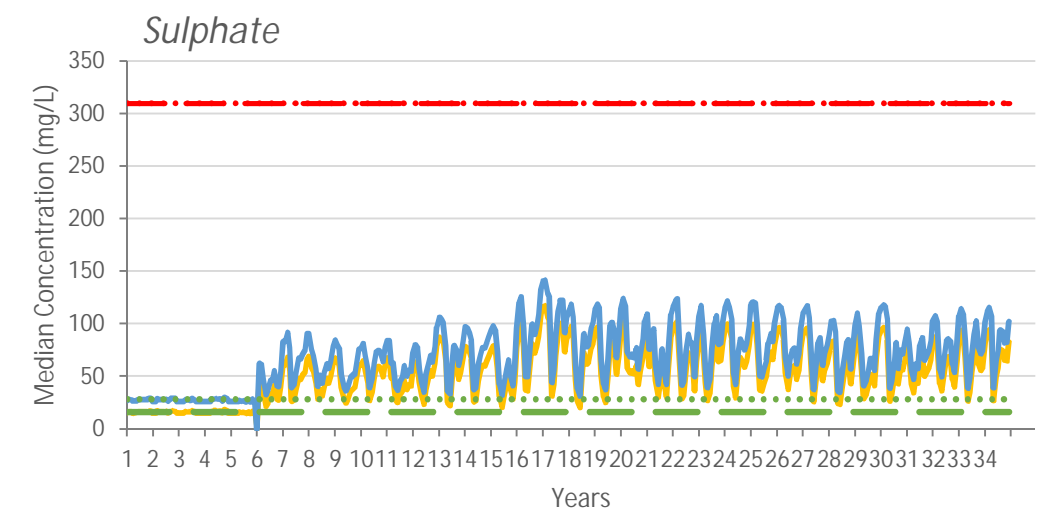
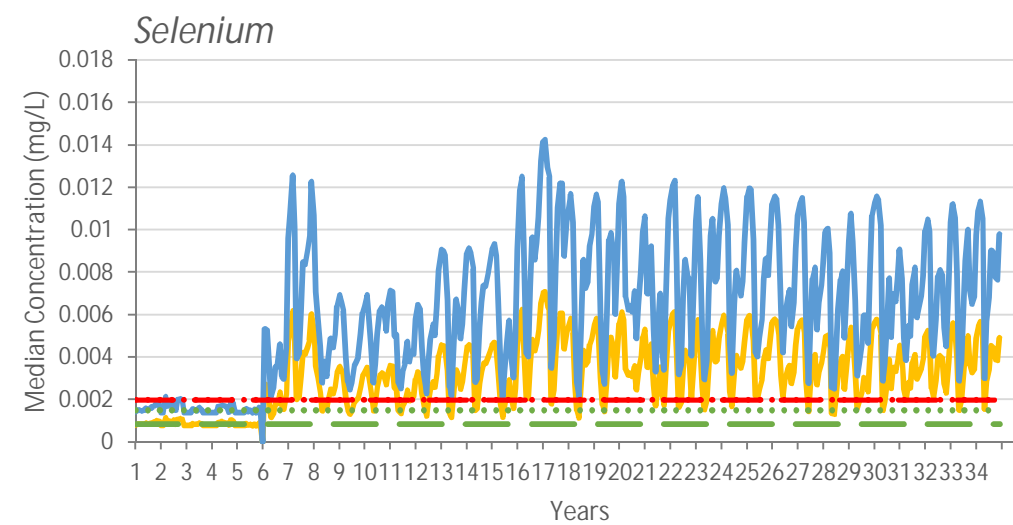
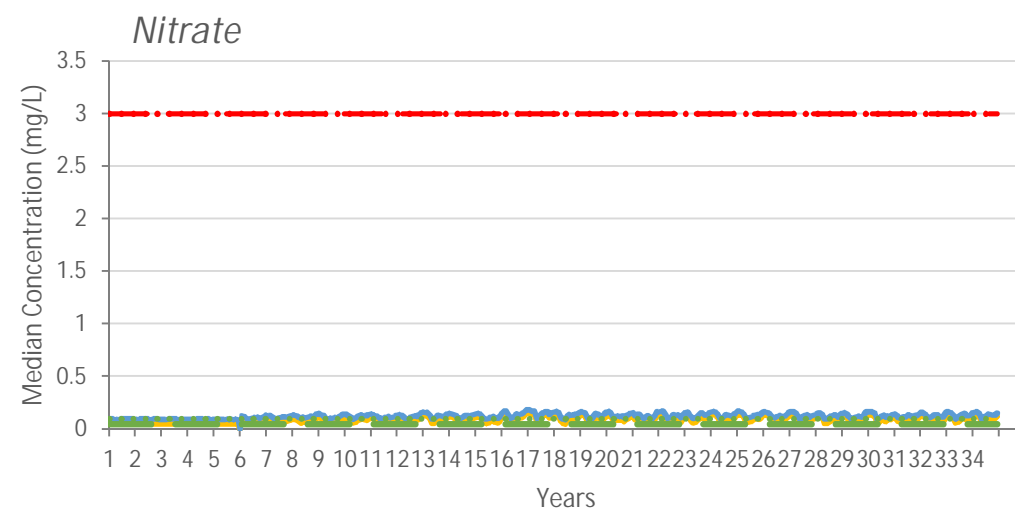
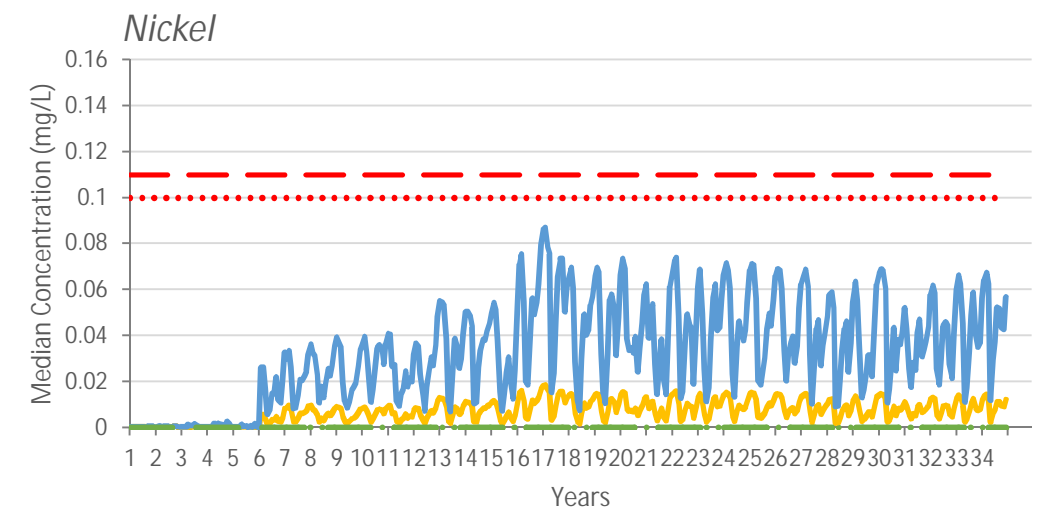
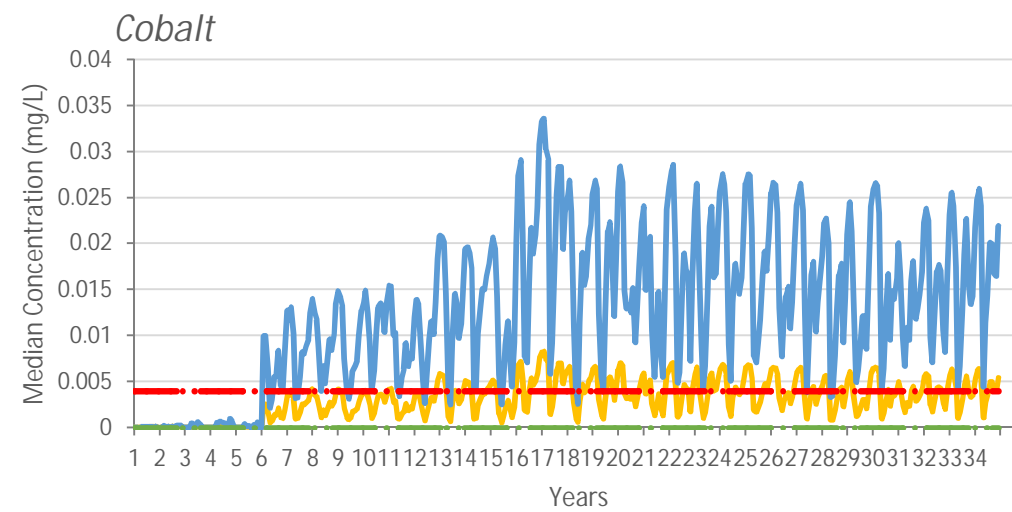
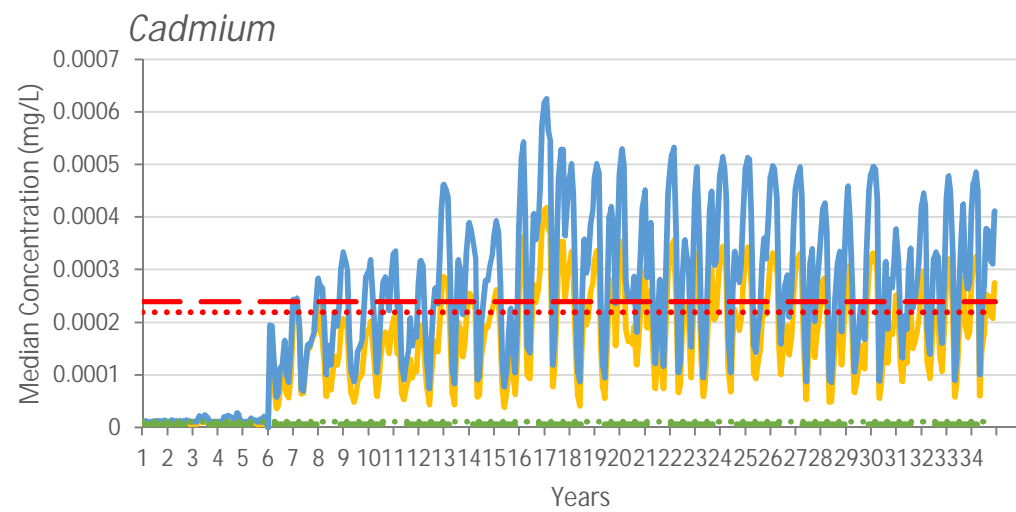


Figure 11.5-8: Water Quality Predictions for West Alexander Creek Node AC-6
 Crown Mountain Coking Coal Project
 Application for an Environmental Assessment Certificate / Environmental Impact Statement

Selenium concentrations are predicted to increase above the B.C. WQG of 0.002 mg/L from Year 6 until Year 34, with guideline exceedances occurring year round. Maximum concentrations reach 0.014 mg/L in Year 17 in the 95th percentile scenario, and 0.007 mg/L in Year 17 in the 50th percentile scenario. Selenium concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. Concentrations below the guideline occur between freshet and late summer/early fall every year in the 50th percentile results, but primarily remain elevated above guideline value year round in the 95th percentile scenario.

Sulphate

Median sulphate concentrations in West Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain similar to background water quality for the first 5 years of Pre-Production and Operations, and increase in concentration by approximately 50% after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-8). Sulphate concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. However, sulphate concentrations are predicted to remain below the B.C. WQG of 309 mg/L throughout the Project life in both the 50th and 95th percentile scenarios.

11.5.4.2.3 Results – Alexander Creek

Water quality predictions in Alexander Creek were assessed at nodes AC-3, AC-2, and AC-1 (Figure 11.5-2). Similar trends were observed for each of the metals evaluated and are described in detail in the following subsections.

Cadmium

Median cadmium concentrations in Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain well below the hardness-dependent long-term chronic B.C. WQG for the first 5 years of Pre-Production and Operations, but slightly increase to approximately 3 times background concentration after Year 5 when the Main Sediment Pond begins to discharge to the creek. This trend is predicted at each of the Alexander Creek nodes assessed:

- AC-3 downstream of the confluence with West Alexander Creek (Figure 11.5-9);
- AC-2 midway between AC-3 and AC-1 (Figure 11.5-10); and
- AC-1 near Highway 3 (Figure 11.5-11).

Concentrations gradually decrease in the system downstream of Highway 3 for both the 50th and 95th percentile scenarios. Cadmium concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. However, cadmium concentrations are predicted to remain below the B.C. WQG throughout the Project in both the 50th and 95th percentile scenarios.

Cobalt

Median cobalt concentrations in Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain well below the long-term chronic B.C. WQG of 0.004 mg/L for the first 5 years of Pre-Production and Operations, and increase in concentration by approximately 75 times (95th percentile) and 30 times (50th percentile) after Year 5 when the Main Sediment Pond begins to discharge to West Alexander Creek. At AC-3, downstream of the confluence with West Alexander Creek (Figure 11.5-9), no

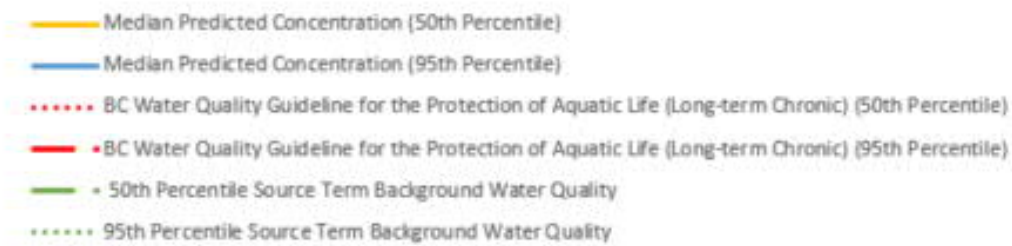
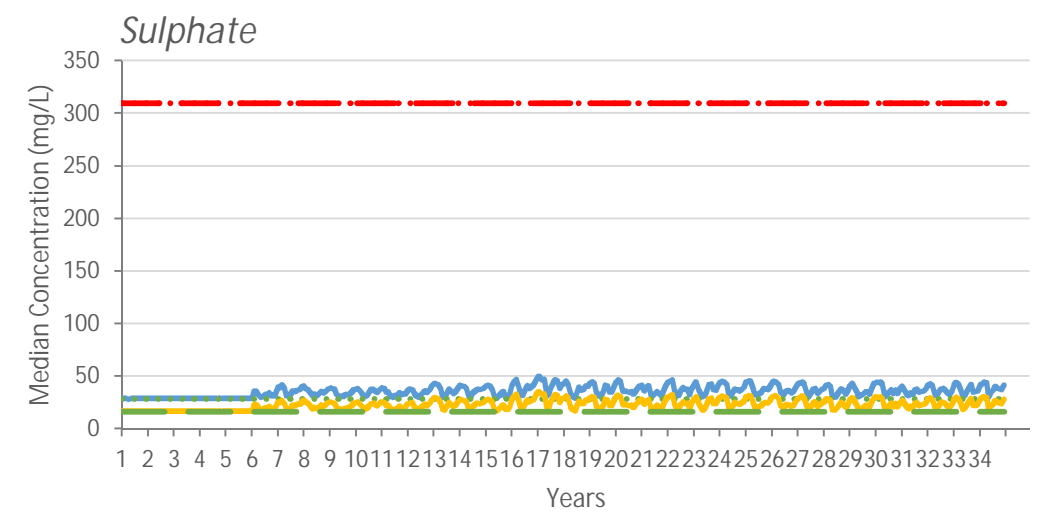
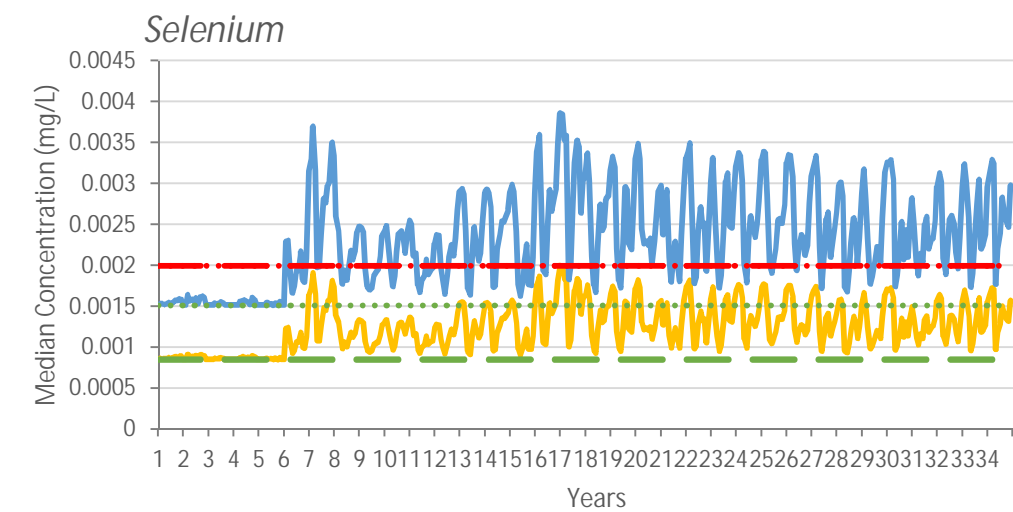
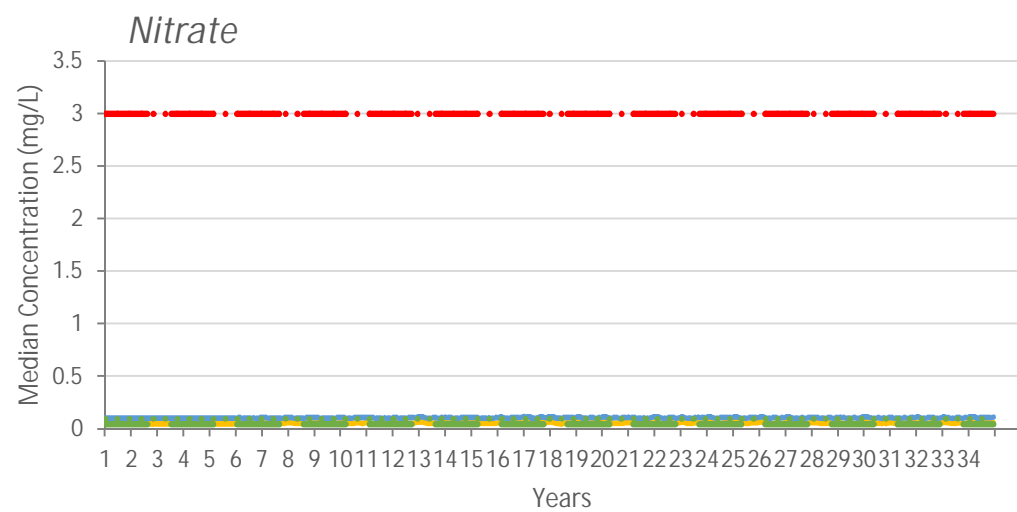
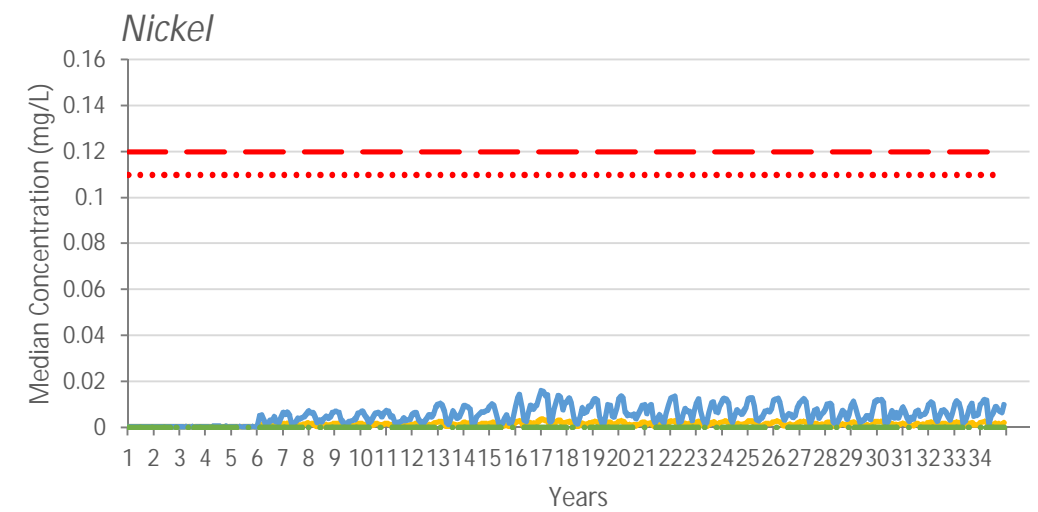
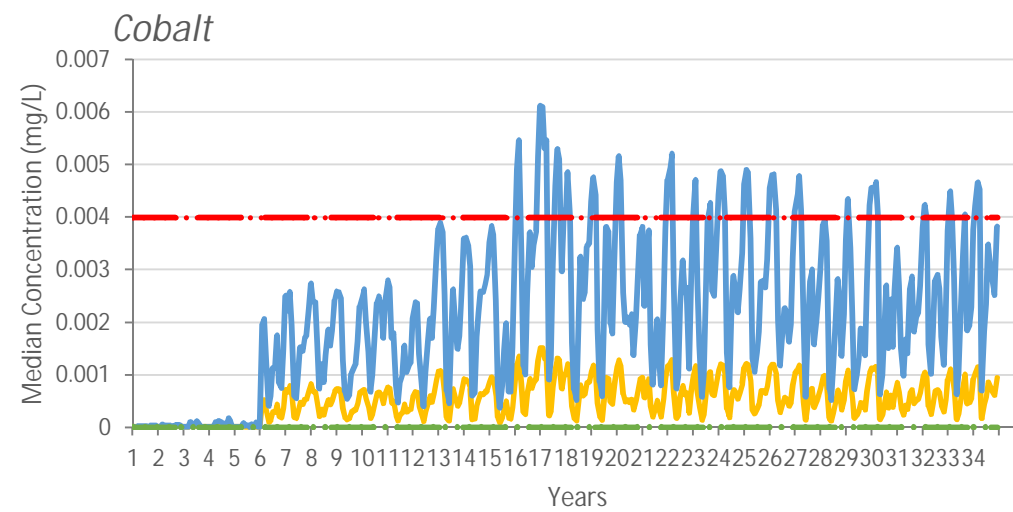
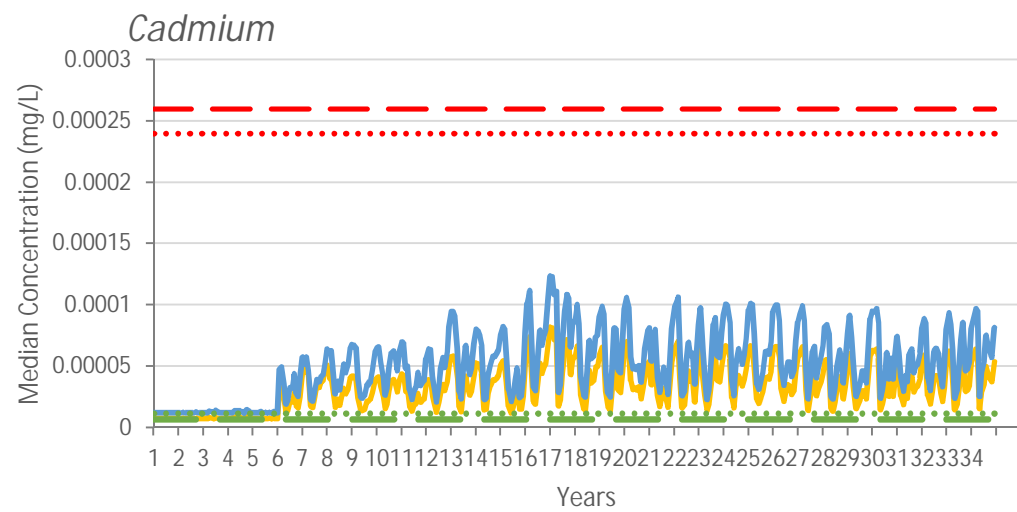


Figure 11.5-9: Water Quality Predictions for Alexander Creek Node AC-3

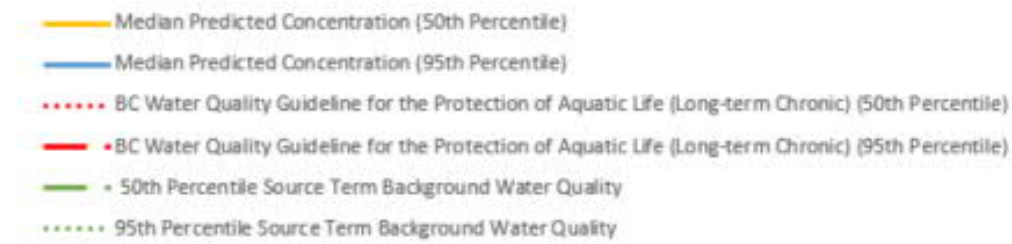
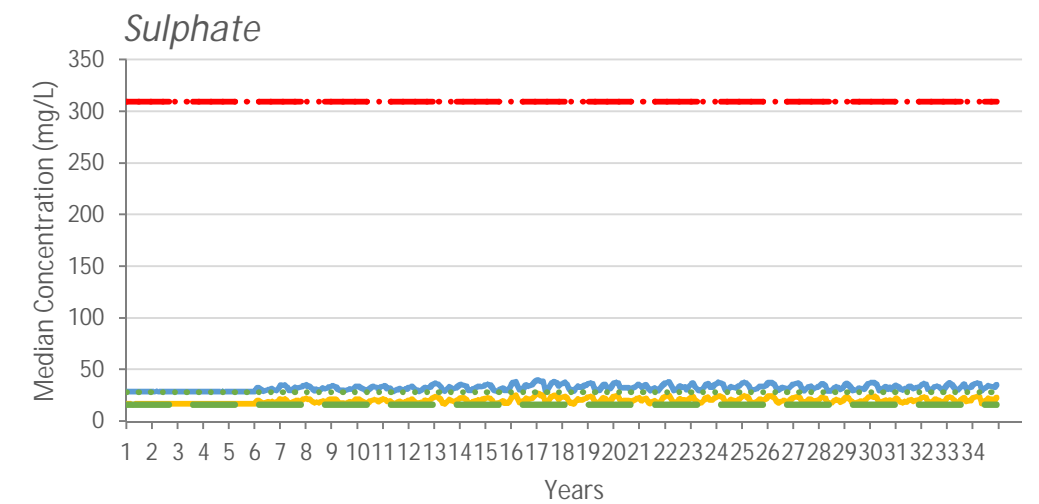
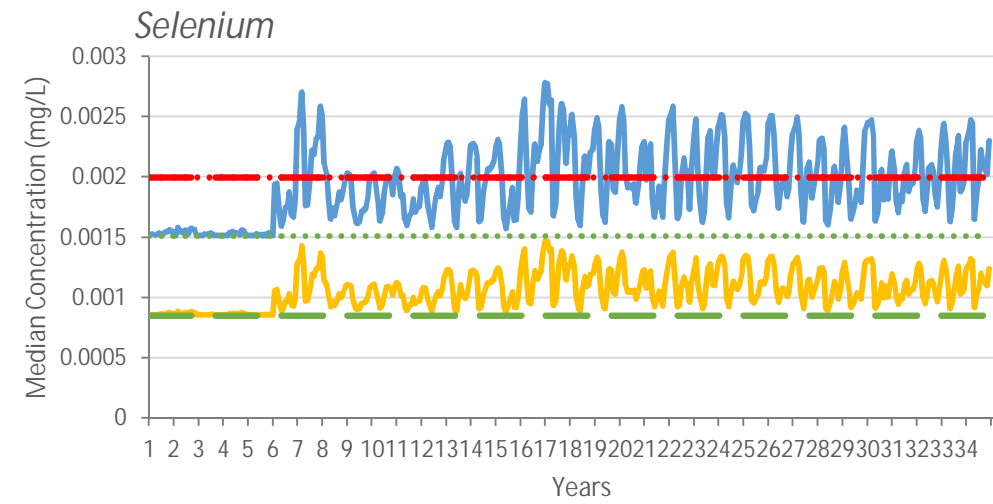
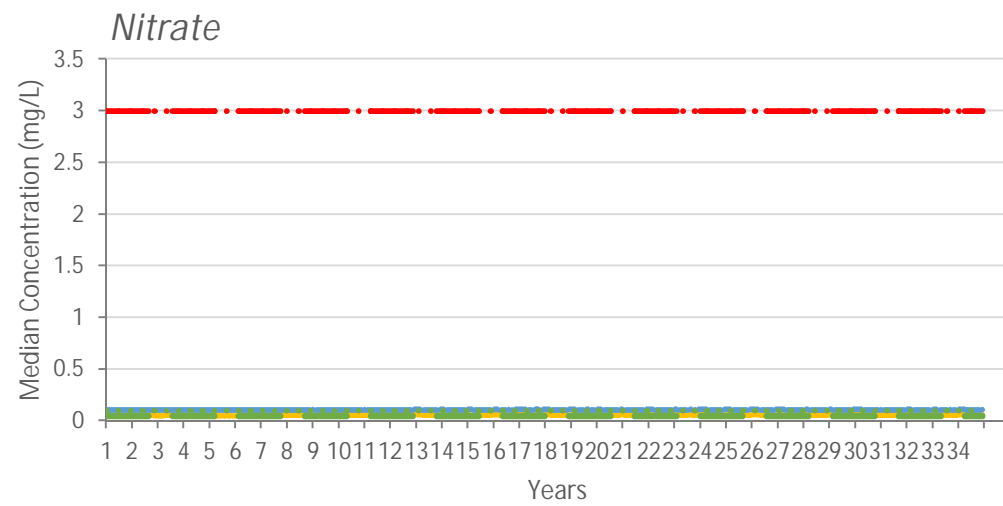
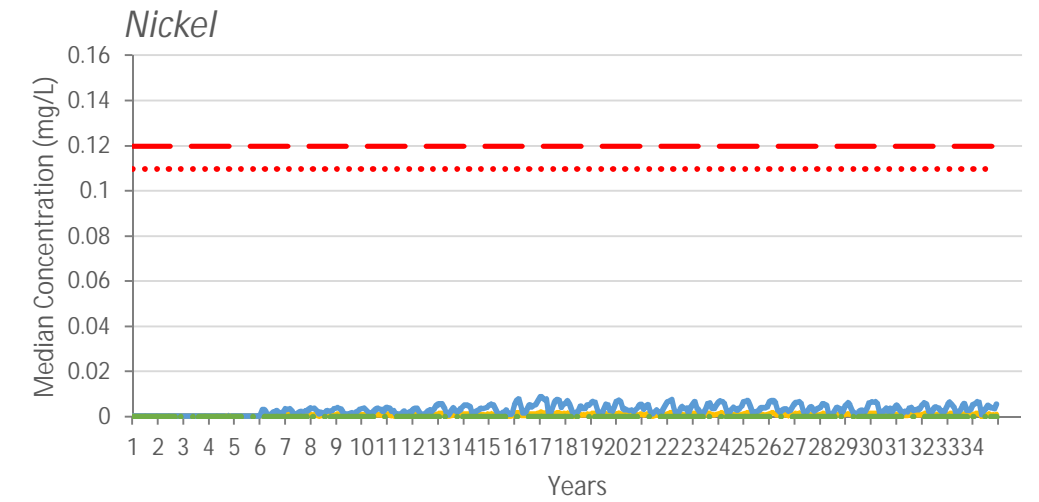
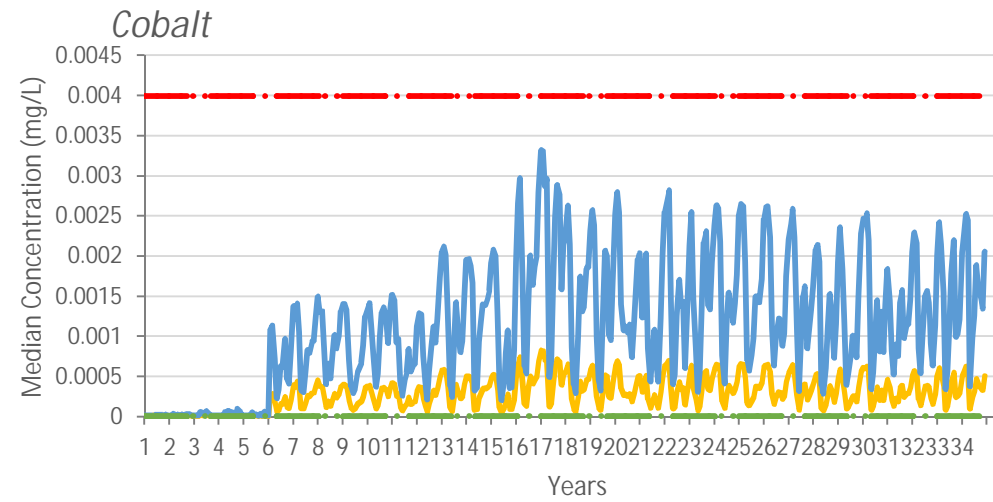
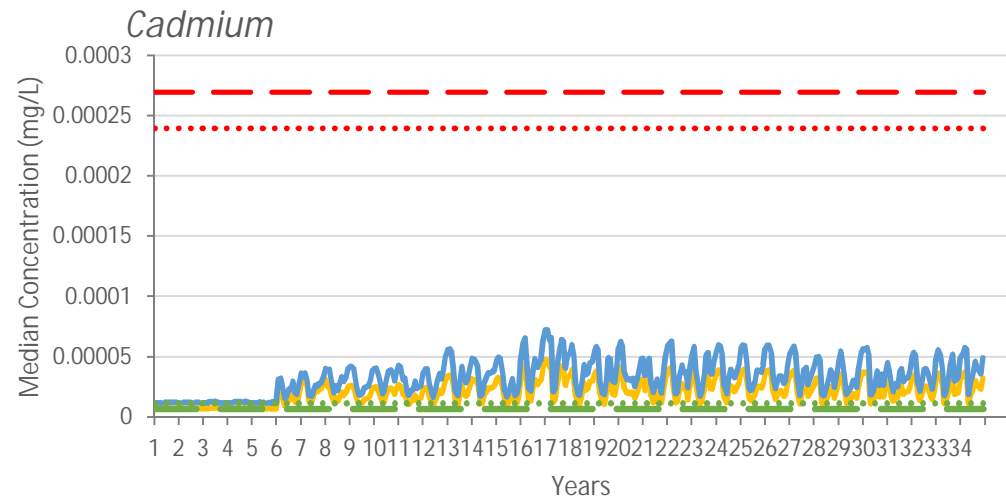


Figure 11.5-10: Water Quality Predictions for Alexander Creek Node AC-2

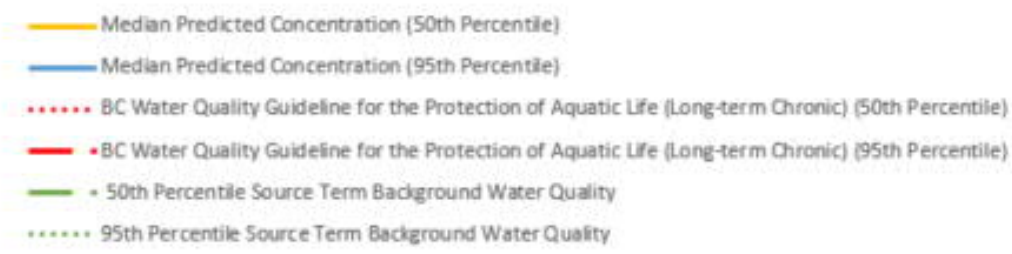
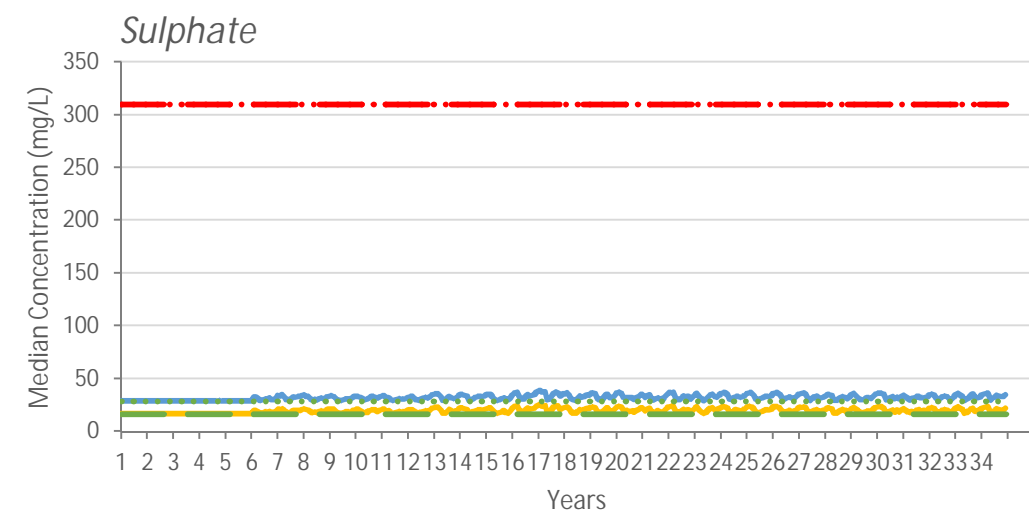
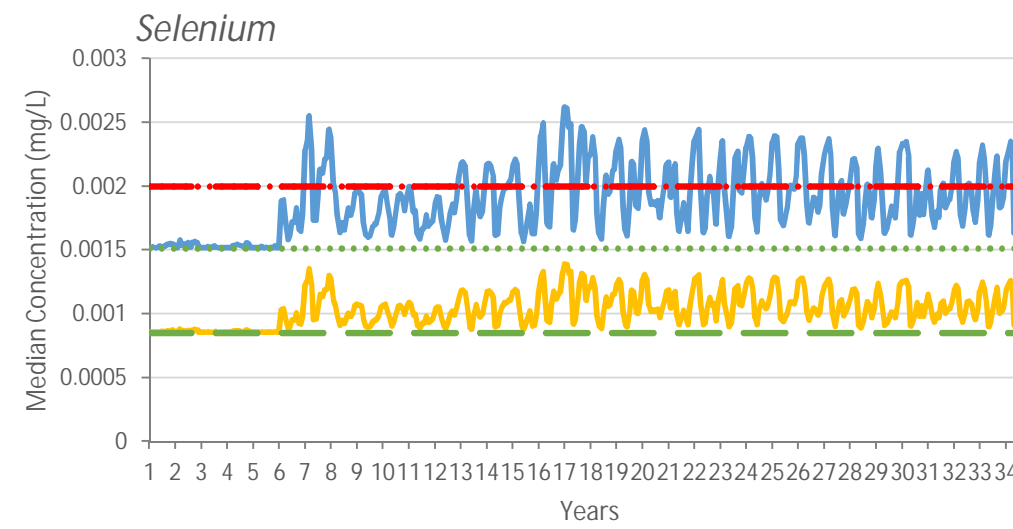
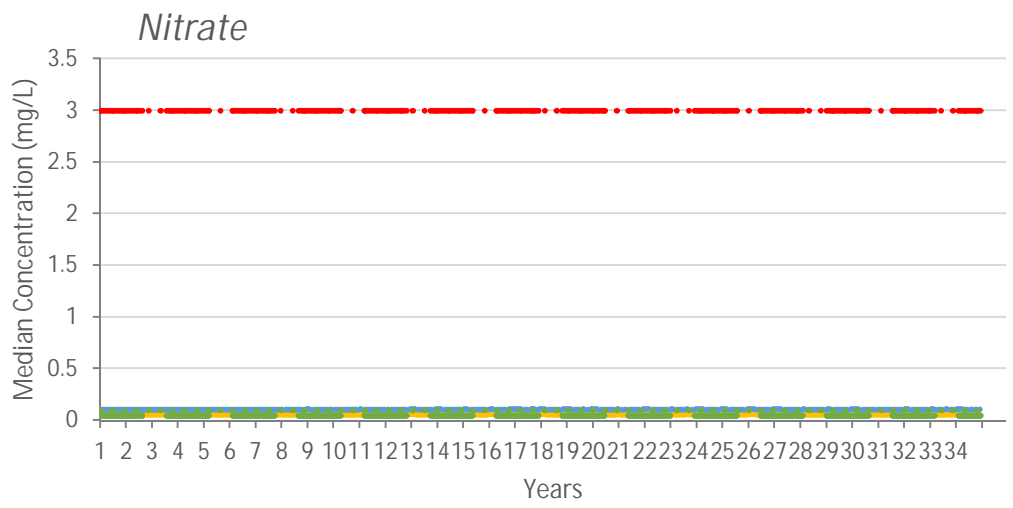
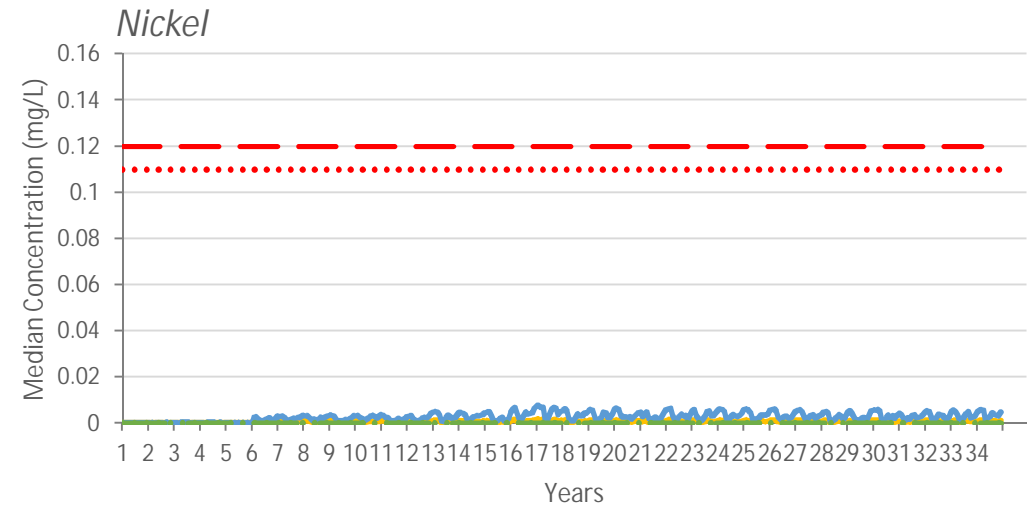
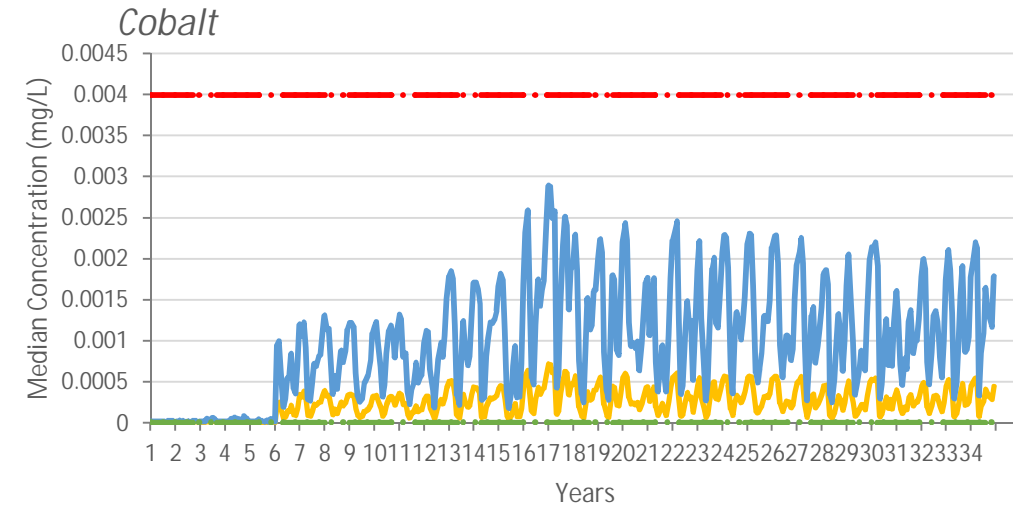
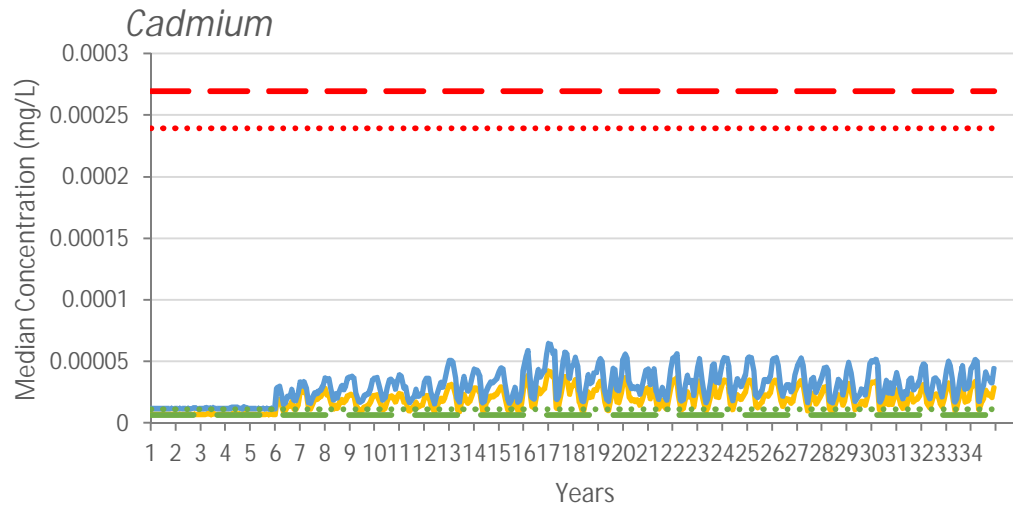


Figure 11.5-11: Water Quality Predictions for Alexander Creek Node AC-1
 Crown Mountain Coking Coal Project
 Application for an Environmental Assessment Certificate / Environmental Impact Statement

cobalt exceedances occur until Year 16, reaching a maximum of 0.0061 mg/L in Year 17 in the 95th percentile scenario. No cobalt exceedances occur at nodes AC-2 and AC-1 in the 50th percentile scenario, with a maximum concentration of 0.0015 mg/L in Year 17.

Cobalt concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. Concentrations well below guideline value occur between freshet and late summer/early fall every year in the 50th percentile scenario, with occasional exceedances at AC-3, usually in the winter, in the 95th percentile scenario.

Nickel

Median nickel concentrations in Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain well below the long-term chronic hardness-dependent B.C. WQG for all Project phases and only increase in concentration by approximately 25% to 50% greater than background after Year 5 when the Main Sediment Pond begins to discharge to the creek. This trend occurs at all Alexander Creek nodes (Figure 11.5-9; Figure 11.5-10; Figure 11.5-11). Concentrations gradually decrease downstream as Alexander Creek flows toward Highway 3.

Nickel concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. As noted previously, nickel concentrations are predicted to remain well below the B.C. WQG throughout the Project life in both the 50th and 95th percentile scenarios.

Nitrate

Median nitrate concentrations in Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain well below the long-term chronic B.C. WQG of 3 mg/L throughout all phases of the Project and show minimal deviation from background levels at all Alexander Creek nodes in both assessment scenarios (Figure 11.5-9; Figure 11.5-10; Figure 11.5-11).

Selenium

Median selenium concentrations in Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain well below the long-term chronic B.C. WQG of 0.002 mg/L for the first 5 years Pre-Production and Operations, and increase in concentration at each node by approximately 125% after Year 5 when the Main Sediment Pond begins to discharge to the creek (Figure 11.5-9; Figure 11.5-10; Figure 11.5-11).

No selenium exceedances occur at AC-3, AC-2, or AC-1 in the 50th percentile scenario, with a maximum concentration of 0.002 mg/L at AC-3 in Year 17. In the 95th percentile scenario, at AC-3, B.C. WQG exceedances occur every year between Year 6 and Year 34, reaching a maximum of 0.0038 mg/L in Year 17. At AC-2, selenium exceedances occur every year between Year 7 and Year 34, with the exception of Year 12, reaching a maximum of 0.0028 mg/L in Year 17. At AC-1, selenium exceedances occur in Year 7 and Year 8 and from Year 13 to 34, reaching a maximum of 0.0026 mg/L in Year 17.

Selenium concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. Concentrations below the guideline values occur between freshet and late summer/early fall every year in the 95th percentile results at each

node, with increasing frequency of concentrations below guideline downstream in the system toward Highway 3.

Sulphate

Median sulfate concentrations in Alexander Creek for both the 50th and 95th percentile scenarios are predicted to remain well below the long-term chronic B.C. WQG of 309 mg/L for the duration of the Project. Median concentrations increase in concentration by approximately 25% to 50% after Year 5 when the Main Sediment Pond begins to discharge to the creek. This trend occurs at all nodes modelled in Alexander Creek (Figure 11.5-9; Figure 11.5-10; Figure 11.5-11). Concentrations gradually decrease as water moves downstream toward Highway 3.

Sulphate concentrations show a distinct seasonal cycle, with the highest concentrations occurring in the winter and the lowest concentrations occurring during spring freshet. However, sulphate concentrations are predicted to remain below the B.C. WQG of 309 mg/L throughout the Project life in both the 50th and 95th percentile scenarios.

11.5.4.2.4 Results – Elk River

Water quality predictions for nitrate, selenium, and sulphate concentrations in the Elk River were assessed at two regional nodes in the Elk River from the Elk Valley Regional Water Quality Model (Figure 11.5-3):

- EV_ER1: confluence of Elk River and Michel Creek, near Sparwood; and
- RG_ELKORES: Elk River at the Elko Reservoir.

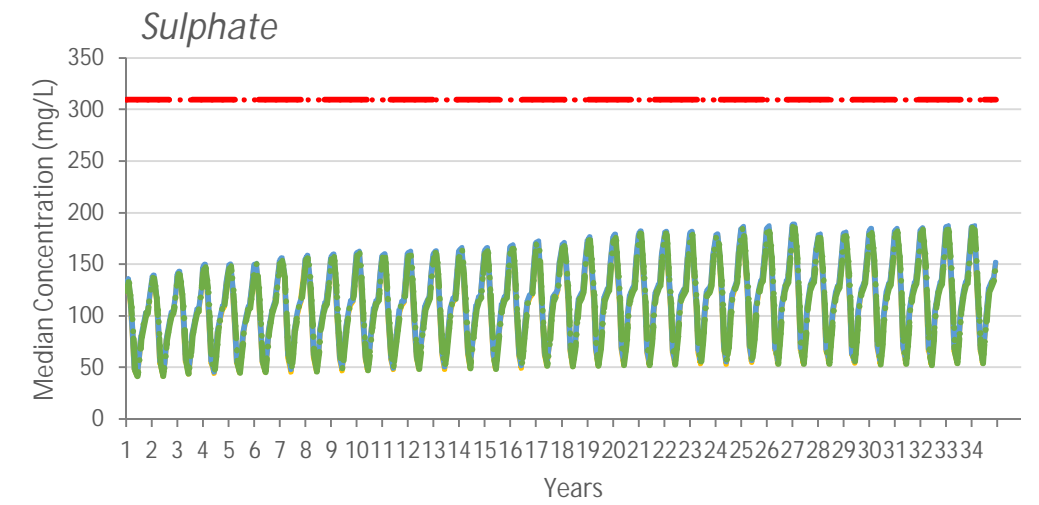
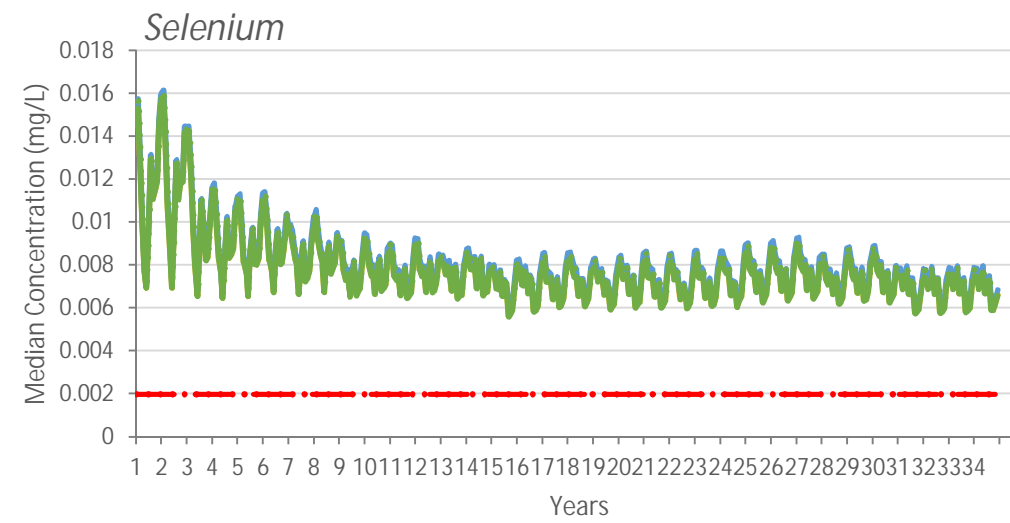
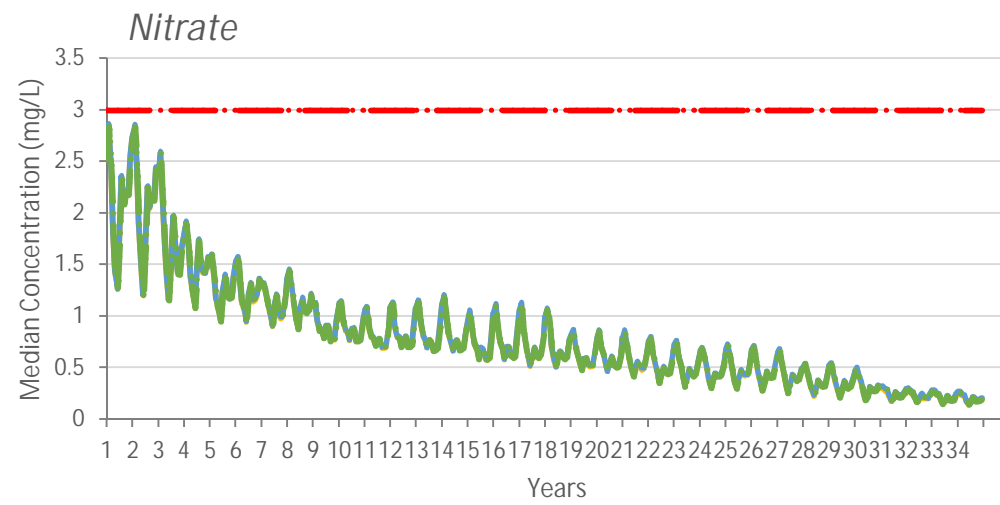
Nitrate

In the Elk River downstream of Michel Creek (EV_ER1), nitrate concentrations for both the 50th and 95th percentile scenarios are consistently below the B.C. WQG and EVWQP long-term water quality target of 3 mg/L and are predicted to gradually decrease over time between Year 1 and Year 34 (Figure 11.5-12). Nitrate predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in the Elk River downstream of Michel Creek as a result of the Project.

A similar trend was observed at the Elko Reservoir (RG_ELKORES) node, with nitrate concentrations consistently well below the B.C. WQG and predicted to gradually decrease over time between Year 1 and Year 34 (Figure 11.5-13). Nitrate predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in the Elk River at Elko Reservoir as a result of the Project.

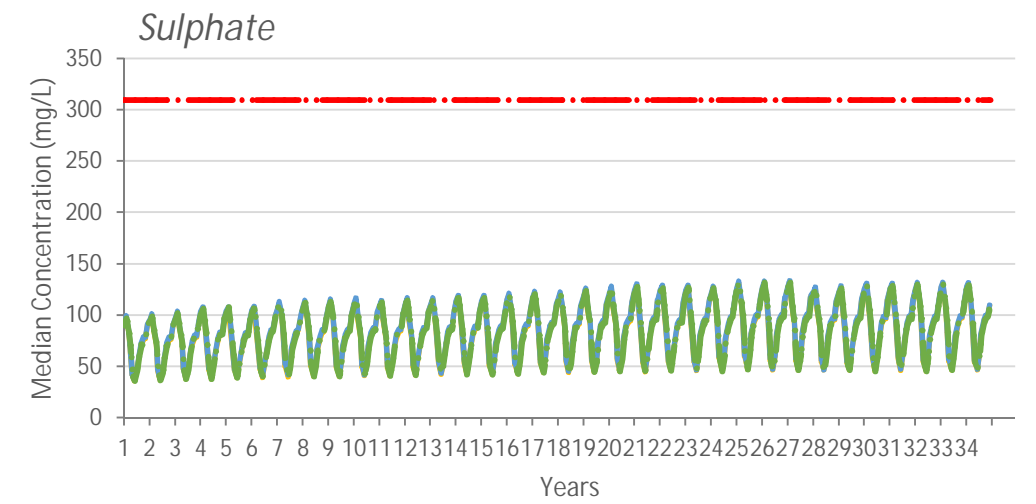
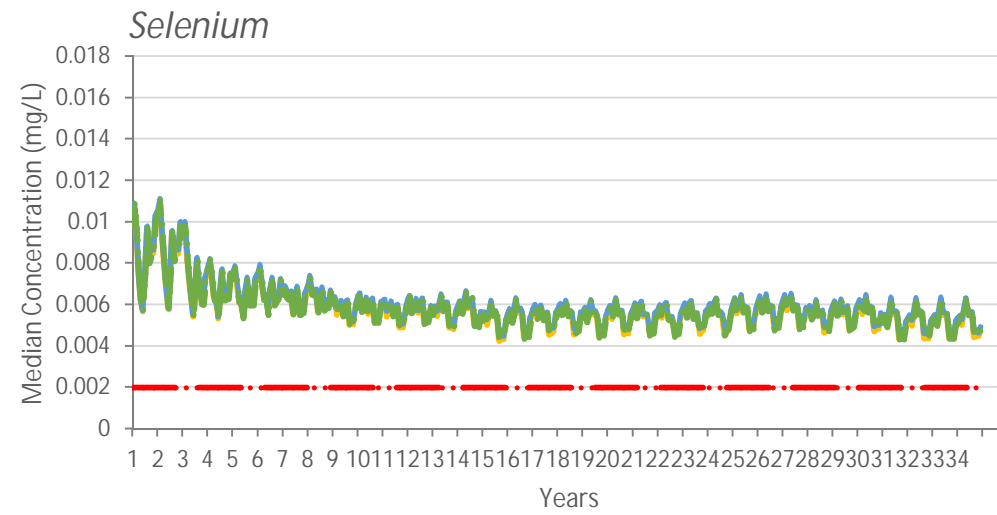
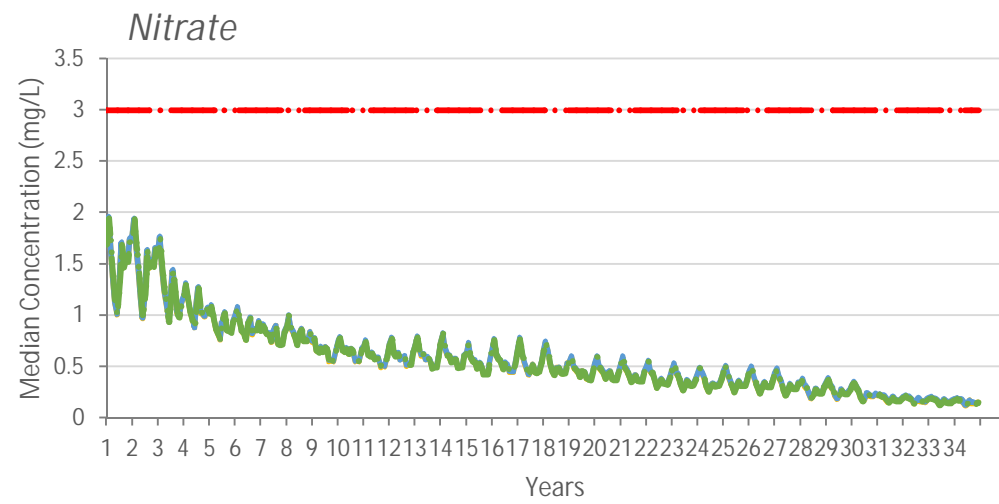
Selenium

At EV_ER1, selenium concentrations for both the 50th and 95th percentile scenarios are consistently elevated above the B.C. WQG of 0.002 mg/L from Year 1 to 34 with a maximum of 0.016 mg/L in Year 1, but are predicted to gradually decrease over time (Figure 11.5-12). Selenium concentrations are predicted to be within the EVWQP long-term water quality target for EV_ER1 of 0.019 mg/L (Teck, 2014). Selenium predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in the Elk River downstream of Michel Creek as a result of the Project.



- Median Predicted Concentration (50th Percentile)
- Median Predicted Concentration (95th Percentile)
- BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (95th Percentile)
- BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (50th Percentile)
- 50th Percentile Source Term Background Water Quality
- 95th Percentile Source Term Background Water Quality

Figure 11.5-12: Water Quality Predictions for Elk River Node EV_ER1



- Median Predicted Concentration (50th Percentile)
- Median Predicted Concentration (95th Percentile)
- BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (95th Percentile)
- BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (50th Percentile)
- 50th Percentile Source Term Background Water Quality
- 95th Percentile Source Term Background Water Quality

Figure 11.5-13: Water Quality Predictions for Elk River Node RG_ELKORES

Similarly, at RG_ELKORES, selenium concentrations are consistently elevated above the B.C. WQG of 0.002 mg/L from Year 1 to 34, with a maximum of 0.011 mg/L in Year 2 but are predicted to gradually decrease over time (Figure 11.5-13). Selenium concentrations are predicted to be within the EVWQP long-term water quality target of 0.019 mg/L (Teck, 2014). Selenium predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in the Elk River at Elko Reservoir as a result of the Project.

Sulphate

At EV_ER1, sulphate concentrations for both the 50th and 95th percentile scenarios consistently are well below the B.C. WQG of 309 mg/L and EVWQP long-term water quality target of 429 mg/L and are predicted to remain relatively constant between Year 1 and Year 34 (Figure 11.5-13). Sulphate predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in the Elk River downstream of Michel Creek as a result of the Project.

At RG_ELKORES, sulphate concentrations consistently are well below the B.C. WQG and EVWQP long-term water quality target and are predicted to remain relatively constant between Year 1 and Year 34 (Figure 11.5-13). Sulphate predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in the Elk River at Elko Reservoir as a result of the Project.

11.5.4.2.5 Results – Lake Koochanusa

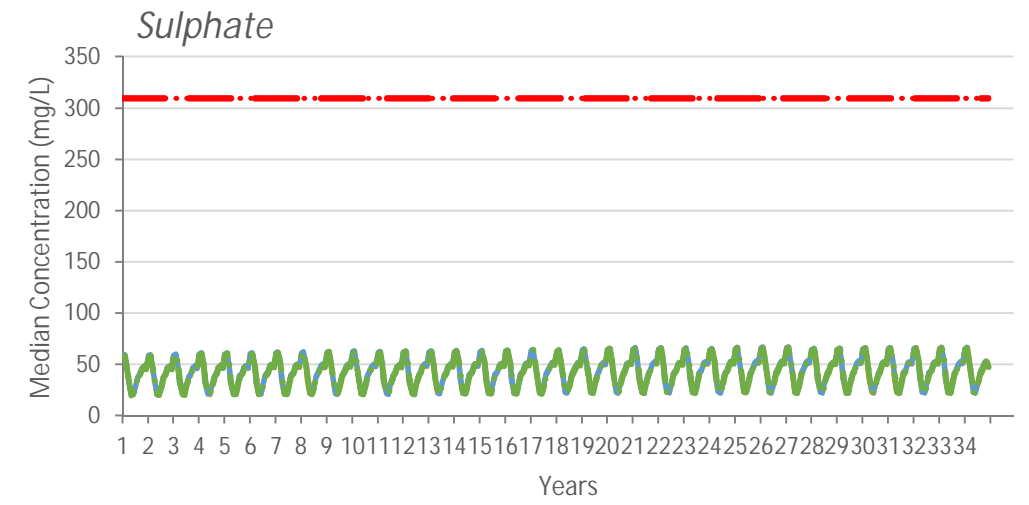
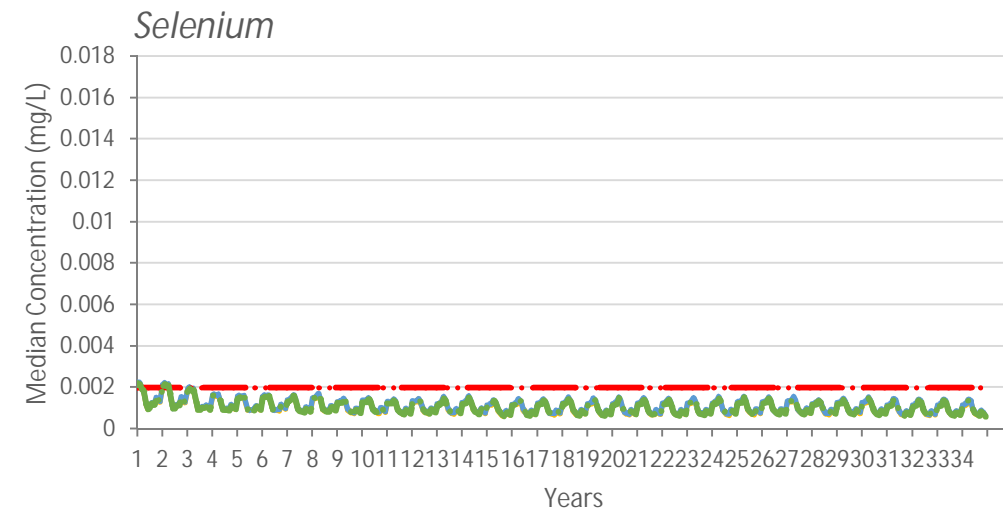
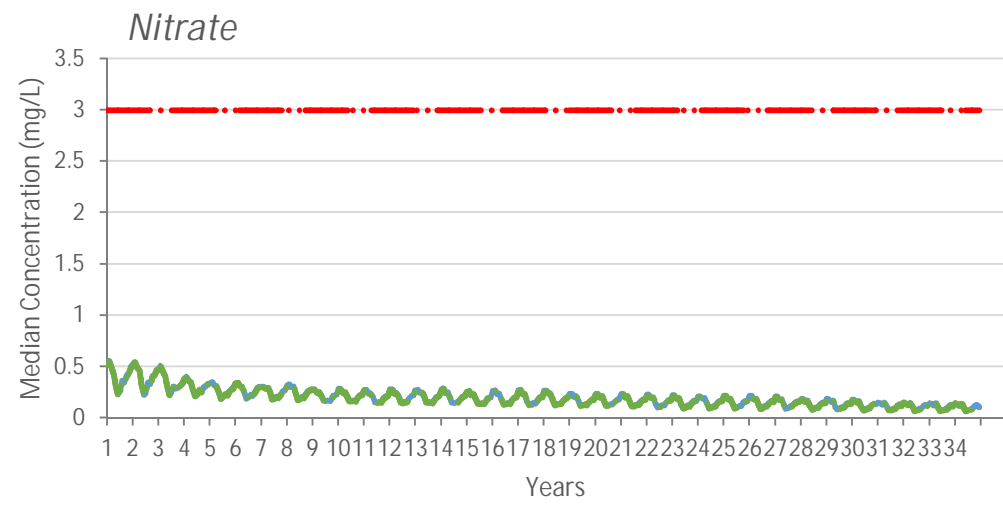
Water quality predictions in Lake Koochanusa were assessed at the RG_DSELK regional node from the Elk Valley Regional Water Quality Model (Figure 11.5-3).

Nitrate

At the RG_DSELK node, nitrate concentrations for both the 50th and 95th percentile scenarios are consistently well below the B.C. WQG and EVWQP long-term water quality target of 3 mg/L and are predicted to gradually decrease over time between Year 1 and Year 34 (Figure 11.5-14). Nitrate predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in Lake Koochanusa as a result of the Project.

Selenium

Selenium concentrations for both the 50th and 95th percentile scenarios appear slightly elevated at RG_DSELK in the winter of Year 1 and Year 2. After Year 3, concentrations are consistently well below the B.C. WQG and EVWQP long-term water quality target for Lake Koochanusa of 0.002 mg/L (Teck, 2014) and are predicted to gradually decrease over time between Year 1 and Year 34 (Figure 11.5-14). Selenium predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there is no measurable change to water quality in Lake Koochanusa as a result of the Project.



- Median Predicted Concentration (50th Percentile)
- Median Predicted Concentration (95th Percentile)
- BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (95th Percentile)
- BC Water Quality Guideline for the Protection of Aquatic Life (Long-term Chronic) (50th Percentile)
- 50th Percentile Source Term Background Water Quality
- 95th Percentile Source Term Background Water Quality

Figure 11.5-14: Water Quality Predictions for Lake Koocanusa Node RG_DSELK
 Crown Mountain Coking Coal Project
 Application for an Environmental Assessment Certificate / Environmental Impact Statement

Sulphate

At RG_DSELK, sulphate concentrations are consistently well below the B.C. WQG of 309 mg/L and EVWQP long-term water quality target of 308 mg/L and are predicted to remain relatively constant between Year 1 and Year 34 (Figure 11.5-14). Sulphate predictions in the 50th and 95th percentile scenarios are not distinguishable from the background water quality scenarios, suggesting there will be no measurable change to water quality in Lake Koochanusa as a result of the Project.

11.5.4.3 Characterization of Residual Effects

The assessment of residual effects on surface water quality involves the consideration and evaluation of specific effects assessment criteria based on the degree (i.e., 'level') of potential Project effects. Criteria used to characterize residual effects are defined in Chapter 5, Section 5.3.4.5 and include duration, magnitude, geographic extent, frequency, reversibility, and context.

11.5.4.3.1 Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects

The residual effect to surface water quality from the disposal of mine rock and coal rejects is characterized as follows:

- Duration: *Permanent*, the potential for ML/ARD from the Mine Rock Storage Facility will persist beyond the 34 year temporal boundary for the Project. However, the potential for ML/ARD is anticipated to decrease over time due to the depletion of constituents in the mine rock.
- Magnitude: *High*, concentrations of cadmium, cobalt, and selenium in surface runoff and seepage from the Mine Rock Storage Facility are likely to exceed B.C. WQG.
- Geographic Extent: *Discrete*, surface runoff or seepage from the Mine Rock Storage Facility will be contained in the Interim or Main Sediment Ponds within the Project footprint and will not enter the receiving environment without monitoring and adaptive management.
- Frequency: *Continuous*, the potential for ML/ARD occurs continuously once the Mine Rock Storage Facility is established.
- Reversibility: *Reversible long-term*, changes in surface water quality resulting from ML/ARD are anticipated to be potentially reversible once the Mine Rock Storage Facility is fully reclaimed through re-vegetation and re-sloping to limit oxygen ingress and leaching effects.
- Context: *Neutral*, seepage/surface runoff from the Mine Rock Storage Facility will be captured and contained with the Interim or Main Sediment Pond prior to discharge to the receiving environment, which will allow for monitoring and adaptive management and minimize the potential for disruption to natural water quality in the receiving environment.

Determination of Significance

The residual effect on surface water quality from the disposal of mine rock and coal rejects from the Project is considered not significant. The proposed engineered mine rock layering design is the Best Achievable Control Technology (BACT) to reduce selenium and nitrate leaching from the Mine Rock Storage Facility and is anticipated to be at least an order of magnitude more effective than other technologies currently being implemented in the Elk Valley (see Section 11.4.1.1.2). All seepage and surface runoff from the Mine Rock Storage Facility will be captured by the water management infrastructure and contained within the Interim or Main Sediment Pond prior to discharge to the receiving environment during Operations, Reclamation and Closure, and Post-Closure. Water in the sediment ponds will be monitored and contingencies will be implemented on an as needed basis that are detailed in the

Site Water Management Plan (Chapter 33, Section 33.4.1.8). Therefore, the disposal of mine rock and coal rejects is not expected to result in the degradation of surface water quality in the receiving environment to the extent that interaction with local surface water results in chemistry changes that may adversely affect aquatic life.

Likelihood and Confidence

Effects that are determined to be not significant do not require a characterization of likelihood.

Confidence considers the reliability of data and analytical methods used in the assessment of effects. The confidence in the characterization of the residual effect to surface water quality from the disposal of mine rock and coal rejects is considered moderate, because, as described in the model assumptions and limitations in Section 11.5.4, water quality inputs to the model were developed from geochemical and hydraulic modelling and are based on a limited number of samples of a large mass of rock that will ultimately produce the impacted runoff and seepage flows. The model explores the possible range of water quality expected in the Project through the use of both average and upper case water quality inputs, but they are only estimations of the water quality that will be experienced by the Project.

11.5.4.3.2 Change in Surface Water Quality from Surface Water – Groundwater Interactions

The residual effect to surface water quality as a result of surface water – groundwater interactions is characterized as follows:

- Duration: *Permanent*, groundwater temporal flow paths will be long (10s to 100s of years), extending well beyond the 34 year temporal boundary for the Project.
- Magnitude: *Low*, the majority of potentially impacted groundwater will be captured by the sediment ponds. Impacted groundwater remaining in the groundwater system will move slowly down-gradient at depth and mix with non-contact waters from other parts of the catchment. The combination of mixing with other groundwater inputs and natural attenuation would further reduce potential risk of impact from these waters, if they discharged to the surface, and is therefore unlikely to result in a definable effect above baseline.
- Geographic Extent: *Discrete*, groundwater modelling suggests that near surface seepage in the overburden unit would not extend beyond approximately 500 m down-gradient of the Mine Rock Storage Facility (to the approximate location of the Main Sediment Pond and remaining within the Project footprint) within 100 years. Seepage in the deeper bedrock system could travel on the order of 1,000 m down-gradient of the Mine Rock Storage Facility over the same time period (SRK, 2021b) and would therefore be contained within the Project footprint.
- Frequency: *Continuous*, surface water – groundwater interactions occur continuously over time.
- Reversibility: *Reversible long-term*, changes in surface water – groundwater interactions are anticipated to be potentially reversible over long temporal scales due to natural attenuation and gradual re-equilibration of the water table and natural groundwater flows.
- Context: *High*, surface water quality is anticipated to be highly resilient to potential changes in surface water – groundwater interactions because impacted groundwater is anticipated to move down-gradient over a long timescale that will allow for natural attenuation and mixing with other, non-contact groundwater inputs before discharging to surface water.

Determination of Significance

The residual effect on surface water quality from surface water – groundwater interactions is considered not significant. The majority of potentially impacted groundwater will be captured by the water management infrastructure and contained within the Interim or Main Sediment Pond prior to discharge to the receiving environment during Operations, Reclamation and Closure, and Post-Closure. The potentially impacted groundwater remaining in the groundwater system will move slowly down-gradient at depth and mix with non-contact waters from other parts of the catchment. The combination of mixing with other groundwater inputs and natural attenuation would further reduce potential risk of impact from these waters, if they discharged to the surface, and is therefore unlikely to result in a definable effect above baseline conditions. Therefore, no direct effect to the receiving environment is expected that may result in water quality concentrations above the thresholds for significance described in Section 11.5.1.

Likelihood and Confidence

Effects that are determined to be not significant do not require a characterization of likelihood.

The confidence in the characterization of the residual effect to surface water quality from surface water – groundwater interactions is considered moderate, because, as described in the model assumptions and limitations in Section 11.5.4, the model is based on a series of expected and conservative assumptions developed to be representative of the water and chemical mass conditions observed at the current, undeveloped site or conditions expected during future development of the Project. The water and load balance by necessity include the simplification of a number of complex natural phenomena, including, but not limited to climate, runoff, snow melt, ice formation, infiltration, and seepage attenuation. The model uses physical models that are only representations of the processes, calibrated to observed baseline data where possible, but many of these processes do not exist in the current, undeveloped conditions and future behaviour cannot be predicted with precision.

11.5.4.3.3 Change in Surface Water Quality from Sediment Pond Discharge

The residual effect to surface water quality from sediment pond discharge is characterized as follows:

- Duration: *Long-term*, changes to surface water quality in West Alexander Creek and Alexander Creek are detectable from Operations through Post-Closure, but guideline exceedances do not occur continuously throughout this period.
- Magnitude: *Moderate*, although B.C. WQG exceedances of cadmium, cobalt, and selenium are predicted to occur in West Alexander Creek and in Alexander Creek upstream of Highway 3 in the 95th percentile (worst case) scenario, 50th percentile (average expected) results show exceedances of these parameters only in West Alexander Creek immediately downstream of the discharge.
- Geographic Extent: *Local/discrete*, changes in 95th percentile surface water quality are detectable beyond the Project footprint in the Aquatic LSA from West Alexander Creek to Alexander Creek upstream of Highway 3, but effects are not detectable in the Elk River at Sparwood or further downstream in the Elk River or Lake Koochanusa. Changes in 50th percentile surface water quality are only detectable in the Project footprint within West Alexander Creek downstream of the sediment pond discharge.

- Frequency: *Regular*, surface water quality guideline exceedances do not occur year-round for most parameters, and concentrations are generally highest in the winter during low-flow conditions.
- Reversibility: *Reversible long-term*, the changes to surface water quality as a result of sediment pond discharge are anticipated to be potentially reversible over long temporal scales as the assimilative capacity of the impacted watercourses may provide some natural resilience to the mine-exposed water, resulting in the potential return to baseline conditions once the sediment pond has been decommissioned after water quality objectives have been met.
- Context: *Neutral*, the receiving environments of West Alexander Creek and Alexander Creek are dynamic systems that naturally experience a wide range of flow and water chemistry conditions, as described in the baseline program results in Section 11.4.2.2. The assimilative capacity of these watercourses may provide some natural resilience to the sediment pond discharge and has the potential return to baseline conditions once the sediment pond has been decommissioned after water quality objectives have been met.

11.5.4.3.4 Determination of Significance

The residual effect on surface water quality from sediment pond discharge is considered not significant, as interaction with local surface water is not anticipated to result in chemistry changes that may adversely affect aquatic life. Exceedances of cadmium, cobalt, and selenium are predicted to occur in West Alexander Creek and as far downstream as Alexander Creek near Highway 3 in the 95th percentile (worst case) scenario from Operations through Post-Closure. However, 50th percentile (average expected) results show exceedances of these parameters only in West Alexander Creek immediately downstream of the discharge and are limited to within the Project footprint. Effects to surface water quality as a result of the Project are not detectable from background conditions in the Elk River and Lake Kocanusa (Section 11.5.4.2; SRK, 2021d). Consequently, no measurable transboundary effects on surface water quality in the U.S.A. are anticipated as a result of the Project.

Based on results provided in this chapter and in Chapter 22, the risk to aquatic life from selenium exposure in West Alexander Creek is suggestive of a low potential magnitude of effect from changes in water quality. As discussed in Chapter 12, direct habitat loss will occur in West Alexander Creek and require offsetting. The water quality exceedances are therefore not predicted to adversely affect aquatic life, as existing habitat will be removed by direct loss and reductions in flow volume.

The model provides an estimation of how water quality is expected to change over time. Water quality in the Interim and Main Sediment Ponds will be monitored and managed to verify it meets all permitting conditions. The monitoring approach and adaptive management program are described in the Follow-up Strategy in Section 11.7.

11.5.4.4 Likelihood and Confidence

Effects that are determined to be not significant do not require a characterization of likelihood.

The confidence in the characterization of the residual effect to surface water quality from sediment pond discharge is considered moderate, because, as described in the model assumptions and limitations in Section 11.5.4, the water and load balance model is based on a series of expected and conservative assumptions developed to be representative of the water and chemical mass conditions observed at the current, undeveloped site or conditions expected during future development of the Project. The water and load balance by necessity include the simplification of a number of complex natural phenomena, including, but not limited to climate, runoff, snow melt, ice formation, infiltration, and seepage attenuation. The model uses physical models that are only representations of the processes, calibrated to observed baseline data where possible, but many of these processes do not exist in the current, undeveloped conditions and future behavior cannot be predicted with precision.

11.5.4.5 Summary of Residual Effects Assessment

Residual effects and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 11.5-8. There are no significant residual effects to surface water quality anticipated as a result of the Project.

Table 11.5-8: Summary of Residual Effects on Surface Water Quality

Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Change in Surface Water Quality from Disposal of Mine Rock and Coal Rejects	<ul style="list-style-type: none"> • Operations • Reclamation and Closure • Post-Closure 	<ul style="list-style-type: none"> • Engineered layering of coal rejects and Mine Rock Storage Facility to limit ML/ARD • Saturated backfill of mine rock with high selenium levels in the East and North Pits • Progressive reclamation of the Mine Rock Storage Facility • Monitoring (rock placement, seepage water, etc.) 	Duration: Permanent Magnitude: Low Geographic Extent: Discrete Frequency: Continuous Reversibility: Reversible long-term Context: High	Not Significant	Moderate
Change in Surface Water - Groundwater Interactions	<ul style="list-style-type: none"> • Operations • Reclamation and Closure • Post-Closure 	<ul style="list-style-type: none"> • Installation of impermeable liners in the Interim and Main Sediment Ponds • Groundwater and surface water quality monitoring 	Duration: Permanent Magnitude: High Geographic Extent: Discrete Frequency: Continuous Reversibility: Reversible long-term Context: Neutral	Not Significant	Moderate
Change in Surface Water Quality from Sediment Pond Discharge	<ul style="list-style-type: none"> • Operations • Reclamation and Closure • Post-Closure 	<ul style="list-style-type: none"> • Diverting clean, non-contact water away from the sediment ponds; where possible • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Treating water prior to discharge as required to minimize calcite formation • Limiting the mine disturbance footprint through Project design and progressive reclamation • Monitoring and adaptive management 	Duration: Long-term Magnitude: Moderate Geographic Extent: Local/Discrete Frequency: Regular Reversibility: Reversible long-term Context: Neutral	Not Significant	Moderate

11.6 Cumulative Effects Assessment

Cumulative environmental effects are the result of Project residual environmental effects interacting with the effects of other past, present, and reasonably foreseeable future projects or activities to produce a combined/overlapping effect. The objective of the cumulative effects assessment is to consider overlapping effects for all residual adverse effects, not only those predicted to be significant (EAO, 2013). The assessment of cumulative effects on the surface water quality VC requires that:

- The Project results in a residual adverse environmental effect on the surface water quality VC;
- A residual Project effect interacts cumulatively with effects from other projects or activities (i.e., an effect of the Project overlaps spatially and temporally with those of other projects or activities that have been or will be carried out);
- The other projects or activities have been or will be carried out and are not hypothetical; and
- The cumulative effect is likely to occur.

Further information regarding the cumulative effects assessment methodology is provided in Chapter 5, Section 5.3.5.

11.6.1 Overview of Residual Effects

A cumulative effects assessment is required for the surface water quality VC because there is a possibility that the following potential Project residual effects may remain after implementation of proposed mitigation measures:

- Change in surface water quality from the disposal of mine rock and coal rejects;
- Change in surface water quality due to surface water – groundwater interactions; and
- Change in surface water quality from the sediment pond discharge.

No past, present, or reasonably foreseeable future projects or activities that may have an adverse effect on surface water quality are expected to spatially or temporally overlap with the residual effects resulting from a change in surface water quality from the disposal of mine rock and coal rejects or a change in surface water quality from surface water – groundwater interactions, as both residual effects are limited to within the extent of the Project footprint. Given that there is no anticipated spatial and temporal overlap between these residual effects and those of other past, present, and reasonably foreseeable future projects or activities, it follows that cumulative effects are not likely to occur. Therefore, the cumulative effects assessment focuses only on a change in surface water quality from the sediment pond discharge, which has the potential to spatially or temporally overlap with currently operating or proposed projects or activities.

11.6.2 Assessment Boundaries

11.6.2.1 Spatial Boundaries

The assessment of cumulative surface water quality effects was conducted at a regional scale and was confined to the Aquatic RSA described in Section 11.2.3.1. As described in Section 11.5.2.3, transboundary effects into Alberta or federal lands will not occur as a result of the Project.

There is the potential for transboundary cumulative effects to surface water quality in Lake Koochanusa to occur during the Operations, Reclamation and Closure, and Post-Closure phases of the Project as a result of the Interim and Main Sediment Pond discharges to the receiving environment in West Alexander Creek. Flow from the sediment ponds will move downstream from Alexander Creek to Michel Creek and subsequently the Elk River to its outlet with Lake Koochanusa.

Regional water quality modelling conducted for the Project (described in detail in Section 11.5.4.1.1) anticipates that transboundary effects into Lake Koochanusa as a result of the Project are negligible and that model predictions for changes to water quality in the Elk River and Lake Koochanusa are within the range of natural variation. As shown in Table 11.6-1, minimum, maximum, and average water quality predictions for nitrate, selenium, and sulphate over the Project life are less than 1% higher than background levels in the 50th percentile (average/expected) scenario. In the 95th percentile (worst case) scenario, predictions are less than 1% higher than the background water quality for all metrics besides the minimum selenium value for the RG_DSELK node in the Canadian portion of Lake Koochanusa (an estimated increase of 1.8%). Given that changes to water quality are predicted to be less than 1% with five decimal places of precision, no transboundary effects to Lake Koochanusa are predicted to occur beyond the range of natural variability. As such, the Aquatic RSA does not extend into the U.S. portion of Lake Koochanusa.

11.6.2.2 Temporal Boundaries

The temporal boundaries for the cumulative effects assessment are the same as those for Project effects, as defined in Section 11.2.3.2.

11.6.2.3 Use of Temporal Cases

The temporal cases used in the assessment of cumulative effects are described as follows:

1. Base Case – Describes the current status of the VC prior to the start of the Project, including all appropriate past and present projects and/or activities. The Base Case for surface water quality is presented in Section 11.4, with explicit reference to the fact that the Base Case generally reflects the contributions of past and present projects and/or activities.
2. Project Case – Describes the status of the VC with the Project in place, over and above the Base Case. For surface water quality, this is assessed using regional model predictions or mass contribution estimates.
3. Future Case – Describes the status of the VC as a result of the Project Case in combination with all reasonably foreseeable future projects and/or activities that could be carried out.

11.6.2.4 Administrative Boundaries

No additional administrative boundaries were considered in the cumulative effects assessment beyond those described in Section 11.2.3.3.

11.6.2.5 Technical Boundaries

The technical boundaries for the cumulative effects assessment are associated to constraints imposed on the assessment due to limitations in the ability to predict the effects of the Project (EAO, 2013).

Table 11.6-1: 50th and 95th Percentile Background and Predicted Water Quality in the Elk River and Lake Kocanusa over the Project Life

Model Node	Parameter		50 th Percentile Background Concentration	50 th Percentile Predicted Concentration	Relative Percent Difference	95 th Percentile Background Concentration	95 th Percentile Predicted Concentration	Relative Percent Difference	Guideline (mg/L)
EV_ER1	Nitrate	Min.	0.04877	0.048765	0.000%	0.09990	0.09990	0.000%	3
		Max.	2.91337	2.920353	0.239%	2.92671	2.93361	0.235%	
		Avg.	0.78642	0.788442	0.256%	0.79776	0.79965	0.236%	
	Selenium	Min.	0.00085	0.000853	0.000%	0.00151	0.00151	0.000%	0.002
		Max.	0.01592	0.015968	0.318%	0.01624	0.01629	0.304%	
		Avg.	0.00778	0.007814	0.376%	0.00808	0.00813	0.506%	
	Sulphate	Min.	16.53558	16.53558	0.000%	28.68000	28.68000	0.000%	310
		Max.	189.27188	190.01106	0.389%	191.00871	191.76727	0.396%	
		Avg.	112.38721	112.83426	0.396%	114.46234	114.90751	0.387%	
RG_ELKORES	Nitrate	Min.	0.048765	0.048765	0.000%	0.08882	0.08905	0.261%	3
		Max.	2.01771	2.02078	0.152%	2.02625	2.02926	0.148%	
		Avg.	0.57184	0.57289	0.183%	0.57999	0.58093	0.162%	
	Selenium	Min.	0.00085	0.00085	0.000%	0.00151	0.00151	0.000%	0.002
		Max.	0.01112	0.01115	0.199%	0.01133	0.01135	0.187%	
		Avg.	0.00579	0.00581	0.294%	0.00601	0.00603	0.415%	
	Sulphate	Min.	16.53558	16.53558	0.000%	28.68000	28.68000	0.000%	310
		Max.	134.45076	134.89735	0.331%	135.87587	136.34659	0.345%	
		Avg.	84.10735	84.36786	0.309%	85.59721	85.85444	0.300%	
RG_DSELK	Nitrate	Min.	0.04877	0.04877	0.000%	0.05463	0.05467	0.081%	3
		Max.	0.56272	0.56291	0.034%	0.56475	0.56493	0.031%	
		Avg.	0.19662	0.19672	0.047%	0.19843	0.19850	0.033%	
	Selenium	Min.	0.00036	0.00037	0.985%	0.00041	0.00041	1.773%	0.002
		Max.	0.00243	0.00244	0.352%	0.00286	0.00287	0.256%	
		Avg.	0.00106	0.00106	0.188%	0.00111	0.00111	0.335%	
	Sulphate	Min.	16.53558	16.53558	0.000%	19.86785	19.86739	-0.002%	310
		Max.	67.65014	67.73810	0.130%	67.98692	68.08029	0.137%	
		Avg.	43.29679	43.33853	0.096%	43.62797	43.66850	0.093%	

Note: **Bold red** values indicated guideline exceedance

For the purpose of the cumulative effects assessment for surface water quality, the technical boundaries relate to constraints with respect to available baseline data, in addition to the limitations and assumptions involved with predictive (water and load balance) models. To undertake the cumulative assessment of surface water quality effects in the Aquatic RSA, the Site Wide Water Quality (SWWQ) model was integrated with the Elk Valley Regional Water Quality Model (RWQM). Due to the different methodologies that were applied to evaluate streamflow in the SWWQ and RWQM models, only the average flow rates and concentrations provided by the RWQM were considered to be suitable for integrating the cumulative effects from the Project into the RWQM results (SRK, 2021d).

No information is publicly available on the predicted effluent concentrations, discharge limits, or effluent discharge volumes for other reasonably foreseeable future projects or activities in the Aquatic RSA; therefore, it was not possible to conduct a quantitative Future Case cumulative effects assessment.

11.6.3 Identifying Past, Present, and Reasonably Foreseeable Projects and/or Activities

Descriptions of the past, present, and reasonably foreseeable projects and/or activities for consideration in the cumulative effects assessment are provided in Chapter 5, Section 5.3.5.3. A summary of the past, present, and reasonably foreseeable projects or activities that are expected to interact with surface water quality, with a potential for adverse cumulative effects, is provided in Table 11.6-2. Locations of the past, present, and reasonably foreseeable future projects or activities are shown in Figure 11.6-1.

Table 11.6-2: Surface Water Quality Interactions Matrix for Potential Cumulative Effects

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
Past or Present Projects and/or Activities that Have Been Carried Out		
Natural Resource Extraction – Mining (past)	I	The effects to surface water quality from past mining projects are reflected in baseline conditions and are therefore implicitly considered in the assessment of cumulative effects.
Coal Mountain Operations	III	Current/ongoing mining operations have a potential for contributing to adverse cumulative effects on surface water quality within the Aquatic RSA through the discharge of effluent containing potential contaminants of concern and mine-site runoff to the Elk River and its tributaries. The Coal Mountain and Elkview Operations discharge into tributaries of the Elk River that are also directly influenced by the Project; consequently, the ranking of potential cumulative effects is higher compared to other existing coal mining projects that would overlap with the Project residual effects in the Elk River only.
Elkview Operations	III	
Line Creek Operations	II	
Fording River Operations	II	
Greenhills Operations	II	
Kootenay West Mine	I	The Kootenay West Mine Project does not spatially overlap with the Elk River watershed or Lake Kocanusa.

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
Elkhorn Quarry West (Windermere Mining Operations)	I	The Elkhorn Quarry West Project does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Energy - Elko Dam	I	Elko Dam is not anticipated to directly influence water quality downstream of the Project; although it controls flows, it is not anticipated to have a discernable influence on the dilution capacity of the Elk River.
Koocanusa Reservoir	I	The Koocanusa Reservoir is not anticipated to directly influence water quality downstream of the Project; although it controls flows, it is not anticipated to have a discernable influence on the dilution capacity of the Elk River or Koocanusa Reservoir.
Marten Phosphate Project	I	The Marten Phosphate Project is not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because the footprint is small and current underground extraction is limited to bulk sample removal.
Forestry	I	Ongoing forestry activities have the potential to affect surface water quality, as forestry operations may result in increased runoff and sedimentation to the Elk River and its tributaries. Information pertaining to water quality effects resulting from forestry activities in the Aquatic RSA is not available; however, interaction with Project residual effects is anticipated to be minimal as the potential parameters of concern identified for the Project (i.e., cobalt, cadmium, nickel, nitrate, selenium, sulphate) are unlikely to be directly influenced by forestry activities.
Energy - Pipelines	I	Past and present pipeline projects/activities are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because pipelines are required to be regularly monitored and maintained to minimize the potential for environmental effects.
Energy - Electrical Transmission	I	Past and present electrical transmission projects/activities are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because there is minimal interaction of transmission lines with watercourses.
Transportation	I	Past and present transportation projects/activities are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because there are environmental best

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
		practices for highway maintenance activities, instream works, and rail operations that are anticipated to minimize the potential for environmental effects.
Recreation and Tourism	I	Past and present recreation and tourism projects/ activities are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA, because land use for recreation and tourism is not anticipated to interact with surface water quality.
Commercial, Residential, and Industrial Use	I	Past and present projects/activities related to commercial, residential, and industrial use are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because these land uses are not anticipated to interact with surface water quality.
Parks and Protected Areas	I	Past and present projects/activities related to parks and protected areas are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because land use within these areas is not anticipated to interact with surface water quality.
Agriculture	I	Past and present agriculture projects/activities are not expected to substantially contribute to adverse cumulative effects on surface water quality within the Aquatic RSA because agricultural land use is anticipated to have a minimal interaction with surface water quality.
Natural Processes or Events	I	Past and present natural processes or events are reflected in baseline conditions and are therefore implicitly considered in the assessment of cumulative effects.
Reasonably Foreseeable Future Projects and/or Activities That Will Be Carried Out		
Michel Coal Project	III	The proposed Michel Coal Project will discharge into Michel Creek upstream of the confluence with Alexander Creek and therefore interacts directly with surface water quality downstream of the Project.
Grassy Mountain Coal Project	I	The proposed Grassy Mountain Coal Project is located in the Crownsnest River watershed, which flows west to east the in Alberta and does not spatially overlap with the Elk River watershed or Lake Kocanusa.
Tent Mountain Mine	I	The proposed Tent Mountain Mine is located in the Crownsnest River watershed, which flows west to east in

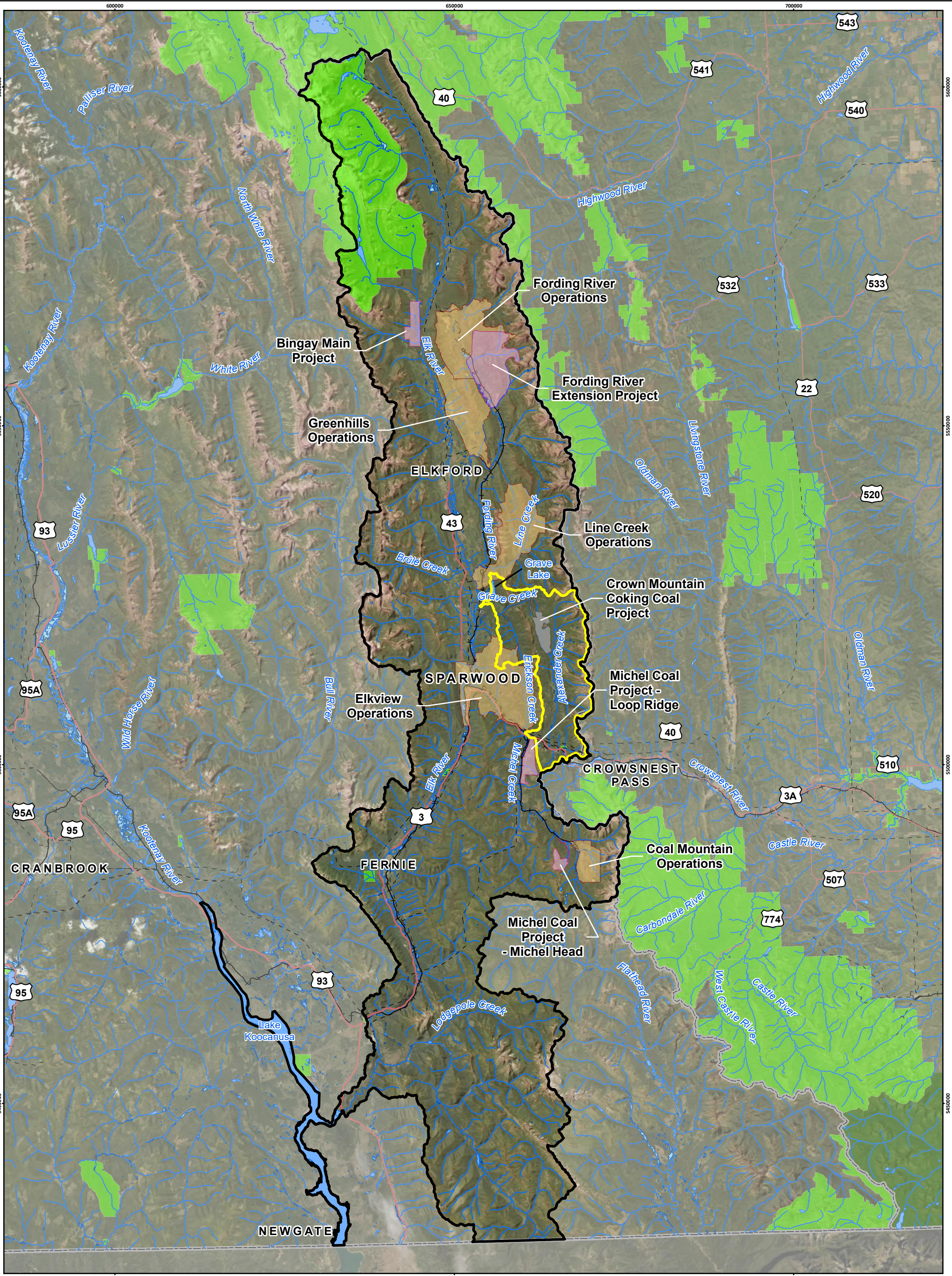
Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect	Justification / Rationale
Fording River Extension Project	II	Alberta and does not spatially overlap with the Elk River watershed or Lake Koocanusa. The proposed Fording River Extension Project will discharge into the Fording River, which flows into the Elk River upstream of the Project; therefore it has the potential to interact with surface water quality in the Elk River and Lake Koocanusa.
Bingay Main Project	II	The proposed Bingay Main Project will discharge into tributaries of the Elk River; therefore, it has the potential to interact with surface water quality in the Elk River and Lake Koocanusa.
Elan Hard Coking Coal Project	I	The proposed Elan Hard Coking Coal Project is located in the Crownsnest River watershed, which flows west to east in Alberta and does not spatially overlap with the Elk River watershed or Lake Koocanusa.
Climate Change	II	Climate change has the potential to impact surface water quality through alterations to air temperature and precipitation, affecting stream flows and, in turn, the mobility and dilution of contaminants.
Natural Processes or Events	I	Future natural processes or events such as floods have the potential to affect local and regional surface water quality, as exemplified by the extreme flooding recorded in the Elk Valley in June 2013. These impacts are anticipated to persist for short periods of time and to be fully reversible and as such are not considered further in the assessment of cumulative effects.

Notes:

I = Residual Project effects do not act cumulatively with those of other past, present, or reasonably foreseeable future projects and/or activities. Not carried forward in the assessment.

II = Residual Project effects act cumulatively with those of other past, present, or reasonably foreseeable future projects and/or activities, but are unlikely to result in significant cumulative effects; or residual Project effects act cumulatively with existing significant cumulative effects but the Project will not measurably contribute to these cumulative effects on the VC. Carried forward in the assessment.

III = Residual Project effects act cumulatively with those of other past, present, or reasonably foreseeable future projects and/or activities, and may result in significant cumulative effects; or residual Project effects act cumulatively with existing significant cumulative effects and the Project may measurably contribute to adverse changes in the state of the VC. Carried forward in the assessment.

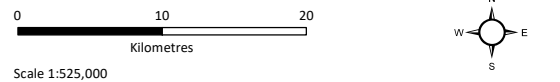


Crown Mountain Coking Coal Project

Figure 11.6-1
Present and Reasonably Foreseeable Projects and Activities with the Potential to Contribute to Cumulative Effects in the Aquatic RSA

LEGEND

- | | |
|--------------------------------------|------------------------------------|
| Projects and Activities | —+— Railway |
| ■ Certain (Present) | - - - Transmission Line |
| ■ Reasonably Foreseeable Future | — Watercourse |
| ■ Aquatic Regional Study Area | ■ Waterbody |
| ■ Aquatic Local Study Area | ■ Wetland |
| ■ Crown Mountain Coking Coal Project | ■ Provincial Park/Protected Area |
| — Highway | ■ National Park |
| | ■ British Columbia/ Alberta Border |



Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada, Elk Valley Water Quality Plan.
Imagery Provided By ESRI.
Map Created By: RB
Map Checked By: HEB
Map Coordinate System: NAD 1983 UTM Zone 11N



Project: 12-6231
Status: FINAL
Date: 2022-01-21

As noted in Chapter 5, Section 5.3.5.3, the following projects were considered as past, present, or reasonably foreseeable future projects and/or activities in the cumulative effects assessment but were not included:

- Coal Mountain Phase 2 as the environmental assessment was placed on hold by Teck Coal Limited in 2016;
- Mount Brussilof (Baymag Mine) by Baymag due to no temporal overlap;
- Barnes Lake Phosphate Exploration Project by Fertoz International Inc. given that the project is in exploration phase and no project has been proposed; and
- Cabin Ridge Coal by Warburton Group is in exploration and no project has been proposed.

11.6.4 Identification of Cumulative Effects

A review of past, present, and reasonably foreseeable future projects or activities was conducted to identify potential cumulative interactions for surface water quality within the Aquatic RSA. The results of the assessment are summarized as follows:

- Potential effects to surface water quality from past mining projects are reflected in baseline conditions; therefore, these effects are implicitly considered in the Base Case for the assessment of cumulative effects;
- Existing and proposed linear infrastructure (i.e., electrical transmission, pipelines, and transportation) is not expected to result in a measurable contribution to adverse cumulative effects on surface water quality and are thus not carried forward in the cumulative effects assessment;
- Other industries and land uses, including agriculture and recreation and tourism account for a very small proportion of the Aquatic RSA and are not identified having the potential to contribute substantially to adverse cumulative effects on surface water quality and are thus not carried forward in the cumulative effects assessment; and
- The projects and activities identified as having a potential to interact cumulatively with the predicted residual Project effects primarily include the currently ongoing and proposed mining operations in the Aquatic RSA.

The projects and activities with a potential to adversely contribute to cumulative effects on surface water quality are summarized in Table 11.6-3.

Table 11.6-3: List of Projects and Activities with Potential to Adversely Contribute to Cumulative Effects on Surface Water Quality

Project/Activity	Project Life	Proponent	Watershed or Sub-Watershed
Coal Mountain Operations	Currently operating	Teck Coal Limited	Michel Creek
Elkview Operations	Currently operating	Teck Coal Limited	Grave/Alexander Creeks
Line Creek Operations	Currently operating	Teck Coal Limited	Line Creek
Fording River Operations	Currently operating	Teck Coal Limited	Fording River
Greenhills Operations	Currently operating	Teck Coal Limited	Elk/Fording Rivers

Project/Activity	Project Life	Proponent	Watershed or Sub-Watershed
Michel Coal Project	Proposed	North Coal	Michel Creek
Fording River Extension Project	Proposed	Teck Coal Limited	Fording River
Bingay Main Project	Proposed	Centermount Coal Ltd.	Elk River
Climate Change	Ongoing	N/A	Regional

Numerous studies have been conducted on the Elk River and associated tributaries with regards to the water quality effects from legacy mining activities. In 2014, the Elk Valley Water Quality Plan was approved by the provincial government to address the cumulative effects of the existing mining operations in the Elk Valley. This plan set forth regional targets for the existing operations to address water quality issues related to selenium, nitrate, sulphate, and cadmium. The fifth water quality issue identified in the EVWQP, calcite deposition, is limited to tributaries of the Elk and Fording Rivers and is addressed through site-specific measures, primarily the use of anti-scalants. The long-term water quality targets for compliance points in each EVWQP Management Unit are summarized in Table 11.6-4.

Table 11.6-4: Summary of Long-term Water Quality Targets in the Elk Valley Water Quality Plan

Management Unit	Description	Order Station	Selenium (µg/L)	Nitrate (mg/L)	Sulphate (mg/L)	Cadmium (µg/L)
1	Upper Fording River (upstream Josephine Falls)	FR4	57	11	429	0.39
2	Lower Fording River	FR5	40	11	429	0.39
3	Elk River upstream Fording River	ER1	19	3	429	0.24
4	Elk River from Fording River to Michel Creek	ER2	19	3	429	0.24
5	Elk River downstream Michel Creek	ER3, ER4	19	3	429	0.24
6	Lake Koochanusa	LK2	2	3	308	0.19

The Project is located within the designated area of the EVWQP. Because the EVWQP is a cumulative effects management plan for water quality that was approved by the Minister of Environment under the EMA (2003), a typical cumulative effects assessment for water quality was not required for the Project under the provincial AIR (EAO, 2018). Instead, the Application/EIS must describe how the water quality targets at the downstream order stations and calcite management objectives of the EVWQP and the EVWQP Approval Conditions in the Minister's letter are met. The relevant compliance points in the EVWQP for the Project include ER3, ER4, and LK2 summarized in Table 11.6-4. Although not required in the AIR, a full cumulative effects assessment on surface water quality was completed for conservatism and to assess surface water quality in the Elk River, Lake Koochanusa, and tributaries as required by the EIS Guidelines (Canadian Environmental Assessment Agency, 2015).

Project-specific and regional watershed modelling for surface water quality to predict the concentrations of the four Order constituents are described in Section 11.5.4.1.1. The existing projects included in the

Elk Valley Regional Water Quality Model (RWQM) predictions provided to NWP by the Ministry of the Environment in December 2019 are as follows:

- Elkview Operations;
- Line Creek Operations;
- Coal Mountain Operations;
- Greenhills Operations; and
- Fording River Operations.

The water quality model developed for the Project includes the water quality issues identified in the EVWQP and is based on historical and projected water quality information from the existing operations summarized above. It is understood that the projected regional water quality results in the RWQM include the projected mining activities for the existing mines and water treatment of mine affected water. The water quality model developed for the Project therefore includes water quality projections for the current operations listed above. Projected water quality predictions as a result of the proposed Michel Coal Project, Bingay Main Project, and Fording River Extension Project were not made available to NWP. However, these projects are also subject to the EVWQP and will be required to meet the relevant long-term water quality targets summarized in Table 11.6-4.

Climate change has the potential to contribute to cumulative impacts to surface water quality through alterations to air temperature and precipitation, which may affect stream flows and, in turn, the mobility and dilution of contaminants. As such, climate change was incorporated into the SWWQ model and RWQM, as described in Section 11.5.4.1.1. However, climate change is predicted to result in negligible impacts to surface water quality at regional nodes in the Elk River, as exemplified by 50th and 95th percentile median selenium concentrations at EV_ER1 in Figure 11.6-2. As such, climate change was excluded from the remainder of the cumulative effects assessment.

11.6.5 Mitigation for Cumulative Effects

The mitigation strategy developed for Project effects is also applicable to the cumulative effects for surface water quality. As described in Section 11.5.3, the mitigation measures include a combination of Project design features, procedures, and practices aimed at reducing or eliminating Project-related effects to surface water quality. Existing and proposed mitigation measures for current coal mining operations and reasonably foreseeable projects in the Elk Valley are also described in this section.

Implementation of the operational practices and procedures that are prescribed in the Site Water Management Plan (Chapter 33, Section 33.4.1.8) will be the primary means by which the Project will address adverse effects to surface water quality. The proposed selenium treatment method for the Project is designed to minimize selenium release and therefore not materially add to the cumulative water quality effects in the Elk River and Lake Koocanusa. The contributions of selenium to the water quality at Order Station ER3 (which corresponds to EV_ER1 in the RWQM), ER4 (corresponding to RG_ELKORES), and LK2 (corresponding to RG_DSELK) are not distinguishable from the “no mine” scenario as described in Section 11.5.4.2, suggesting there will be no measurable change to water quality in the Elk River or Lake Koocanusa as a result of the Project and that the long-term water quality targets at these Order Stations will be met if the Project is constructed.

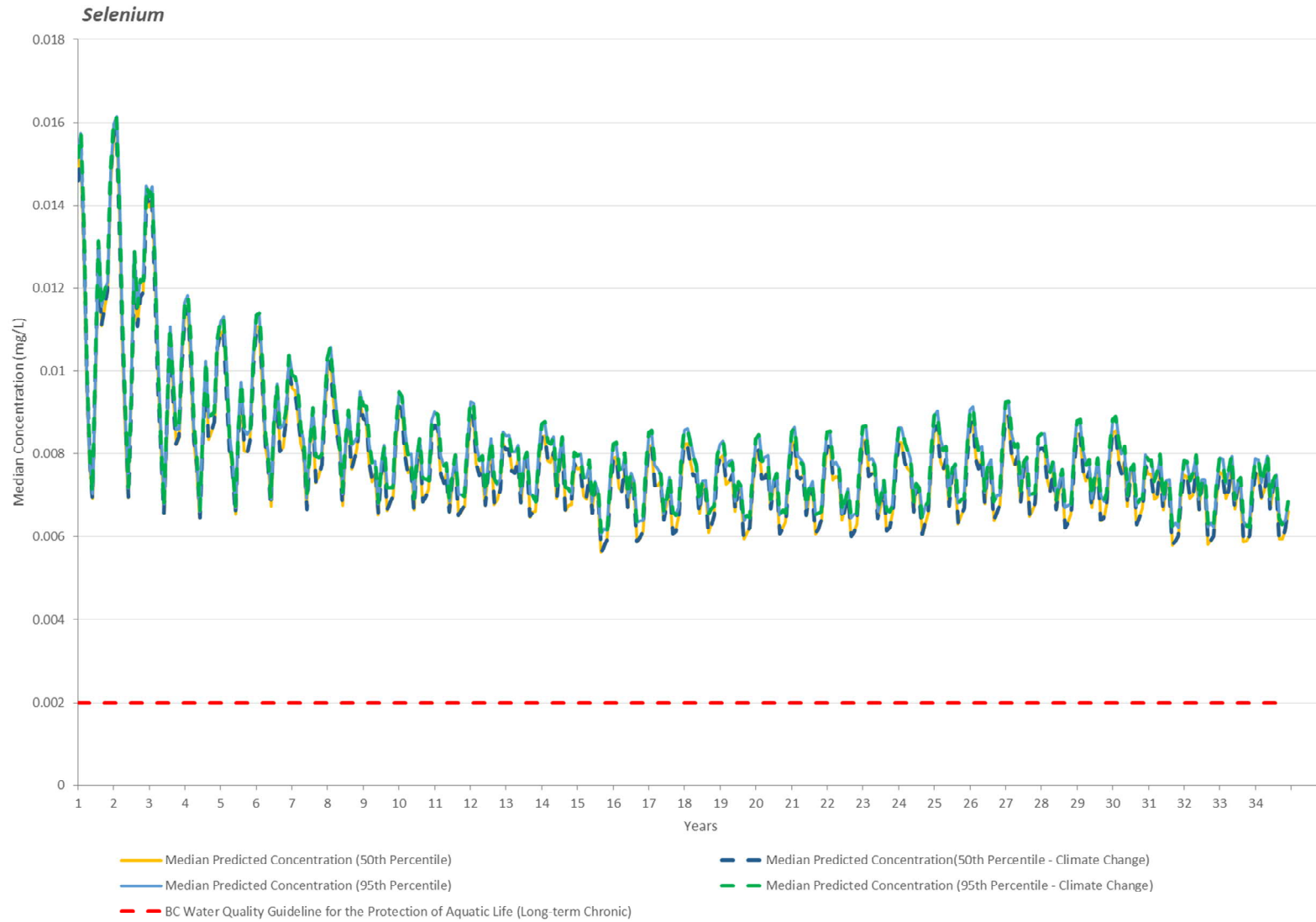


Figure 11.6-2: Selenium Predictions for Elk River Node EV_ER1, With and Without Climate Change

Crown Mountain Coking Coal Project
 Application for an Environmental Assessment Certificate / Environmental Impact Statement

A key part of the EVWQP is the requirement to treat mine-affected water. The Initial Implementation Plan in the EVWQP proposed the treatment of 130,000 cubic metres (m³) of mine-affected water per day by 2034 (Teck, 2014), which relies on active water treatment plants, of which two facilities have been built: one at Fording River Operations and one at Line Creek Operations.

Teck provided an update to the Initial Implementation Plan based on emerging technologies in 2019, which include saturated rock fill, gravel bed reactors, cover design, mine rock storage facility construction, and nitrate control. Based on these technologies, an Alternative Treatment Mitigation Plan was developed (Teck, 2019). This plan would treat an additional 60,000 m³ per day by 2034, which would result in the following:

- Meeting selenium compliance limits approximately 21 months sooner at the EVO Michel Creek Compliance location; and
- Meeting limits at Lake Koochanusa earlier compared to the 2019 Implementation Plan Adjustment (end of 2021 or sooner; Teck, 2019).

The conceptual water quality source control and treatment designs and plans for the Fording River Extension Project include the following concepts (Teck, 2020c):

- Avoid or reduce impacts to water;
- Manage water so that discharges are compliant with release criteria;
- Integrate with the Fording River Operations and regional water management infrastructure; and
- Adopt a best achievable technology approach; which may include an active water treatment facility, saturated rock fill, or in-situ treatment.

No specific water quality information has been provided to NWP to assess the contribution of the Michel Coal Project to cumulative effects. Based on information presented on the North Coal website (North Coal LTD., 2021), North Coal is implementing the following strategies to reduce selenium levels in effluent:

- Divert water around the mine site: the more North Coal can eliminate mine-water contact, the more water North Coal ensures stays clean;
- Passive water treatment: by using saturated rock fills (SRFs) and creating suboxic rock storage facilities, North Coal can minimize the elements that enter the waterways (i.e., elements like selenium); and
- Active water treatment: where necessary, North Coal will treat water to ensure it is safe for the ecosystem before releasing it.

These strategies are based on similar technologies for selenium treatment to what is proposed for the Crown Mountain Coking Coal Project and suggest that Michel Creek would meet all required water quality targets. Consequently, the Michel Coal Project is not anticipated to materially add to cumulative water quality effects in the Elk River or Lake Koochanusa, but predicted water quality in Michel Creek downstream of the Michel Coal Project has not been provided to NWP. Therefore, the potential for residual cumulative effects to surface water quality in Michel Creek downstream of the confluence with Alexander Creek cannot be ruled out until water quality predictions are made available to NWP.

No specific water quality information has been provided to NWP to assess the contribution of the Bingay Main Project to cumulative effects. Based on information presented in the Updated Project Description (Centermount Coal Ltd., 2017), site runoff and pit water will be captured in sedimentation ponds and

monitored prior to release into the environment. Space for additional treatment facilities is incorporated into the proposed mine design, and geochemical characterization of waste rock is underway to predict potential water quality and treatment requirements (Centermount Coal Ltd., 2017).

Ongoing and continued collaboration between project proponents, government, Indigenous groups, and other stakeholders is necessary to ensure that appropriate mitigation measures are adopted such that adverse cumulative effects on surface water quality are minimized to a practical extent. Proactive mitigation strategies, monitoring programs, and data sharing are of critical importance to fulfil regional objectives laid out in the EVWQP.

To determine whether additional mitigation measures are required to address potential cumulative effects to surface water quality, a collaborative long-term surface water quality monitoring program will be implemented, subject to that approach being acceptable to other nearby proponents. Further details are provided in Section 11.7.

11.6.6 Characterization of Residual Cumulative Effects

The assessment of residual cumulative effects on surface water quality involves the consideration and evaluation of specific effects assessment criteria based on the degree (i.e., 'level') of potential Project effects. Similar to the Project effects assessment, the criteria used to characterize residual effects include duration, magnitude, geographic extent, frequency, reversibility, and context, as defined in Chapter 5, Section 5.3.4.5. The residual cumulative effects were determined based on the B.C. WQG and regional EVWQP long-term water quality targets for the Elk River and Lake Koochanusa, as outlined in Section 11.5.1. Baseline concentrations in Michel Creek and the Elk River exceed the B.C. selenium WQG of 2 µg/L.

As stated previously, the cumulative effects assessment is focused on the single effect that has the potential to result in detectable concentrations of contaminants from the Project in the Aquatic RSA, namely change in surface water quality from sediment pond discharge. No past, present, or reasonably foreseeable future projects or activities that may have an adverse effect on surface water quality are expected to spatially or temporally overlap with the residual effects resulting from a change in surface water quality from the disposal of mine rock and coal rejects or a change in surface water quality from surface water – groundwater interactions, as both residual effects are limited to within the extent of the Project footprint. Therefore, the cumulative effects assessment focuses only on a change in surface water quality from the sediment pond discharge, which has the potential to spatially or temporally overlap with currently operating or proposed projects or activities in the Aquatic RSA.

11.6.6.1 Change in Surface Water Quality from Sediment Pond Discharge

11.6.6.1.1 Base Case

The base case for surface water quality was established through an assessment of surface water quality conditions (i.e., predicted median monthly concentrations) at multiple locations in the Aquatic RSA. The base case accounts for all past and present projects/activities and is intended to serve as the baseline conditions for the assessment of cumulative effects for surface water quality. The base case for surface water quality is described in Section 11.5.4.2 and further detailed in the Water Quality Prediction Model (Appendix 11-F; SRK, 2021d).

11.6.6.1.2 Project Case

The Project case includes all past and present projects or activities which have the potential for contributing to adverse cumulative effects on surface water quality in the Aquatic RSA (via the baseline conditions established for the base case) in combination with the effects of the Project. As listed in Table 11.6-3, there are multiple coal mining projects currently operating in the Elk Valley which have the potential to contribute to adverse cumulative effects on surface water quality.

A quantitative assessment of cumulative effects on surface water quality was undertaken through the preparation of the SWWQ model for the Project case. As demonstrated in Section 11.5.4.3, significant residual effects to surface water quality in Grave Creek, West Alexander Creek, Alexander Creek, and the Elk River and Lake Koochanusa are not predicted to occur as a result of the Project.

Water quality in Michel Creek downstream of Alexander Creek could not be predicted using the SWWQ model due to a lack of sufficient regional water quality and flow data available for Michel Creek. However, SRK conducted a mass comparison of nitrate, selenium, and sulphate contributions in Michel Creek using monthly average flow rates and water quality predictions from the SWWQ node AC-1 (both 50th and 95th percentile results) and water quality and flow data extracted from the B.C. Water Tool at Michel Creek immediately upstream of the confluence with Erickson Creek (accounting for upstream water quality impacts from Teck's Coal Mountain Operations) and Erickson Creek at the confluence with Michel Creek (accounting for downstream water quality impacts from Teck's Elkview Operations). Details on the calculations and estimated water quality results are provided in Appendix 11-I.

As shown in Figure 11.6-3, estimated monthly average nitrate concentrations in Michel Creek downstream of Erickson Creek are anticipated to range from approximately 0.31 to 1.49 mg/L throughout the course of the year in the 95th percentile case (i.e., worst case), with mass contributions from the Project accounting for between 1% and 2.4% of the monthly average nitrate loadings in Michel Creek (Appendix 11-I). The 50th percentile (i.e., expected case) results presented in Figure 11.6-3 are similar to and slightly lower than the 95th percentile values. The predicted nitrate concentrations in both scenarios are well below the B.C. WQG of 3 mg/L and Teck's permit limit of 6 mg/L at EV MC2 (Table 11.4-1).

Estimated monthly average selenium concentrations in Michel Creek downstream of Erickson Creek are anticipated to range from approximately 2.45 to 12.71 µg/L throughout the course of the year in the 95th percentile case, with mass contributions from the Project accounting for between 2.5% and 4.3% of the monthly average selenium loadings in Michel Creek (Appendix 11-I). Baseline concentrations in Michel Creek and the Elk River already exceed the B.C. selenium WQG of 2 µg/L and predicted concentrations in the Project Case will continue to exceed this value; however, the Project is anticipated to account for less than 4.3% of average selenium loadings in Michel Creek. A regional long-term water quality target for selenium does not exist for Michel Creek; however, the predicted selenium concentrations are well below Teck's permit limit of 20 µg/L at EV MC2 that became effective as December 31, 2021 (Table 11.4-1), further suggesting that the Project's contributions to selenium in Michel Creek will have a negligible cumulative impact.

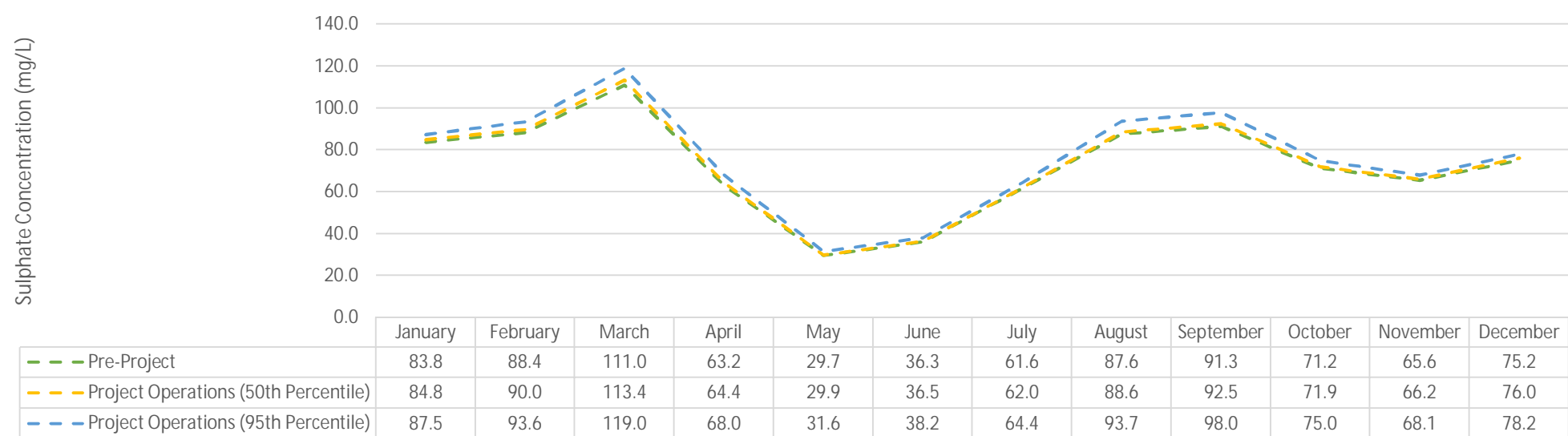
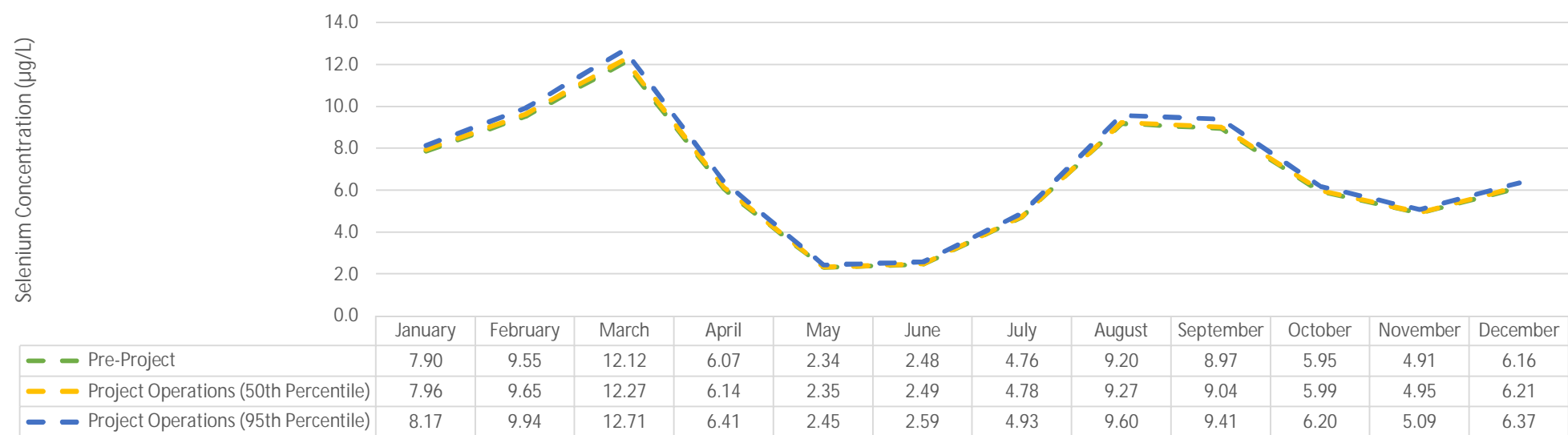
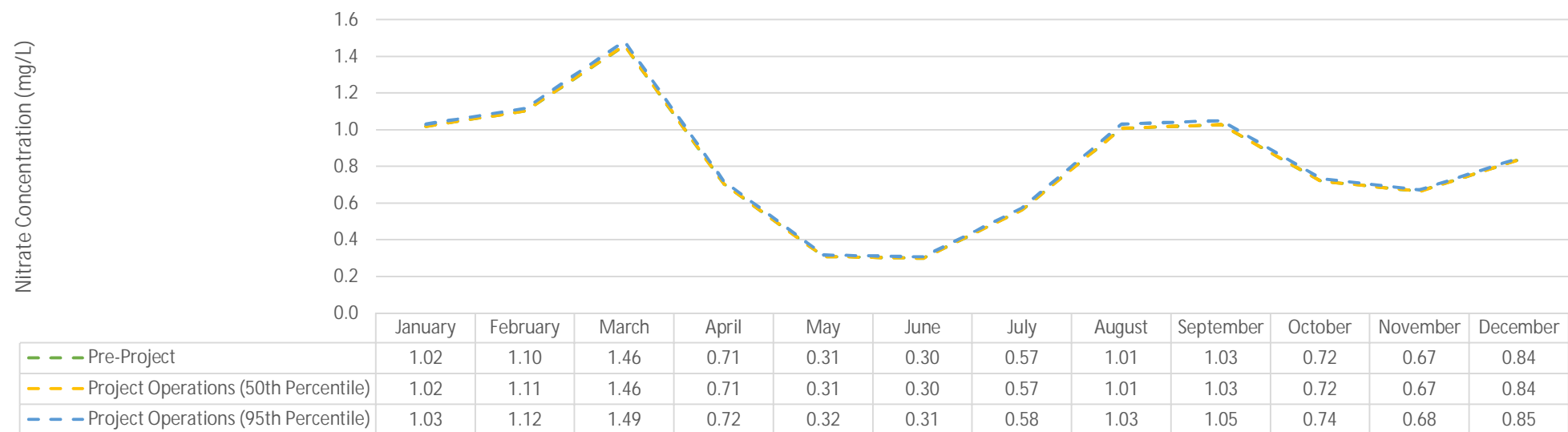


Figure 11.6-3: Estimated Nitrate, Selenium, and Sulphate Concentrations in Michel Creek Downstream of Erickson Creek

Estimated monthly average sulphate concentrations in Michel Creek downstream of Erickson Creek are anticipated to range from approximately 31.6 to 119.0 mg/L throughout the course of the year in the 95th percentile case, with mass contributions from the Project accounting for between 2.6% and 5.6% of the monthly average sulphate loadings in Michel Creek (Appendix 11-I). The predicted sulphate concentrations are well below the B.C. WQG of 309 mg/L; no permit limit exists for sulphate at EV MC2.

The residual cumulative effects of a change in surface water quality from sediment pond discharge in combination with the effects of other past and present projects or activities in the Aquatic RSA (i.e., the Project case) are characterized as follows:

- Duration: *Long-term*, the cumulative change in surface water quality in Alexander Creek upstream of Highway 3 and in Michel Creek downstream of Erickson Creek is detectable from Operations through Post-Closure, but threshold exceedances do not occur continuously throughout this period.
- Magnitude: Low, the cumulative change in surface water quality in Michel Creek downstream of Erickson Creek as a result of the Project is below applicable B.C. WQGs and Teck's existing permit limits for nitrate and selenium at EV MC2 and are not detectable in the Elk River at Sparwood or further downstream in the Elk River or Lake Koochanusa.
- Geographic Extent: *Regional*, the estimated cumulative change in surface water quality occurs within the Aquatic RSA in Michel Creek downstream of the confluence with Erickson Creek; however, cumulative effects are not detectable in the Elk River at Sparwood or further downstream in the Elk River or Lake Koochanusa.
- Frequency: *Continuous*, the potential for adverse cumulative effects to surface water quality will be ongoing because the Project and current mine operations in the Elk Valley are anticipated to discharge to the Elk River and/or its tributaries continuously.
- Reversibility: *Reversible long-term*, the cumulative change in surface water quality as a result of sediment pond discharge is anticipated to be potentially reversible over long temporal scales as the assimilative capacity of the affected watercourses may provide some natural resilience to the mine-exposed water, resulting in the potential return to baseline conditions once the sediment pond has been decommissioned after water quality objectives have been met.
- Context: *Neutral*, the receiving environments of Alexander Creek, Michel Creek, and the Elk River are dynamic systems that naturally experience a wide range of flow and water chemistry conditions. The assimilative capacity of these watercourses may provide some natural resilience to the sediment pond discharge in combination with the effects from other past and present projects or activities in the Aquatic RSA and therefore have the potential to return to base case conditions once the sediment pond has been decommissioned after water quality objectives have been met.

11.6.6.1.3 Future Case

The assessment of cumulative effects for surface water quality under the future case considers the potential for substantive overlapping of the Project effects with those of reasonably foreseeable future projects or activities. As discussed above, there are currently four additional coal mining projects proposed in the Elk Valley. Sufficient data are not available to facilitate a quantitative assessment of cumulative effects on surface water quality in the Aquatic RSA in the future case. However, it is expected that each proposed mine operation will be required to implement appropriate mitigation strategies,

including best available current technologies to minimize or eliminate effects on surface water quality as per the EVWQP.

There is a potential for cumulative surface water quality effects in the lower reaches of Michel Creek from the following ongoing and proposed projects/activities:

- Elkview Operations – Teck Coal Limited (currently operating);
- Coal Mountain Operations – Teck Coal Limited (care and maintenance);
- Crown Mountain Coking Coal Project – NWP Coal Canada Ltd (proposed); and
- Michel Coal Project – North Coal (proposed).

Portions of the existing Elkview Operations and the Project footprint are located within the Alexander Creek watershed, which contributes surface flows to Michel Creek at their confluence (located near the crossing of Highway 3). The existing Coal Mountain Operations and proposed Michel Coal Project are located within the headwater area of the Michel Creek watershed.

As was discussed in the Project case above, several additional currently operating and proposed coking coal mines are located in the northern portion of the Elk Valley, which account for much of the major projects/activities with the potential to adversely contribute to cumulative effects on surface water quality. There is a potential for cumulative/overlapping effects to occur at the confluence of the Elk River and Michel Creek as a result of the following projects/activities, in addition to those listed above:

- Line Creek Operations – Teck Coal Limited (currently operating);
- Fording River Operations – Teck Coal Limited (currently operating);
- Greenhills Operations – Teck Coal Limited (currently operating);
- Bingay Main Project – Centermount Coal Ltd. (proposed); and
- Fording River Extension Project – Teck Resources (proposed).

The cumulative/overlapping effects of these projects on surface water quality in the Aquatic RSA are required to meet the long-term water quality targets for the Elk River and Lake Koocanusa that are outlined in the EVWQP (Teck, 2014). However, there is currently no regional water quality target for Michel Creek, although Teck has permit limits for the Coal Mountain Operations and Elkview Operations in Michel Creek (Table 11.4-1). Baseline selenium concentrations in Michel Creek are in exceedance of the B.C. water quality guideline of 2 µg/L (Section 11.4.1.4). As such, cumulative effects were compared to the compliance point permit limits for Teck's Elkview Operations at EV MC2 (Table 11.4-1). This assessment assumes that through the use of best available current technologies and the addition of discharges from the Crown Mountain Coking Coal Project and Michel Coal Project, water quality in Michel Creek will continue to meet the EV MC2 permit limits of 6 mg/L nitrate and future limit of 20 µg/L selenium (effective December 31, 2021).

The residual cumulative effects of a change in surface water quality from sediment pond discharge in combination with the effects of other reasonably foreseeable future projects or activities in the Aquatic RSA (i.e., the future case) are characterized as follows:

- Duration: *Long-term*, the cumulative change in surface water quality as a result of the Project in Alexander Creek upstream of Highway 3 is detectable from Operations through Post-Closure and have the potential to overlap with residual effects to surface water quality from other reasonably foreseeable future projects or activities discharging to Michel Creek.

- Magnitude: *Low*, this assessment assumes that through the use of best available current technologies, water quality in Michel Creek through the addition of discharges from the Crown Mountain Coking Coal Project and Michel Coal Project will continue to meet the EV MC2 permit limits of 6 mg/L nitrate and future limit of 20 µg/L selenium in lieu of a regional long-term water quality target for Michel Creek.
- Geographic Extent: *Regional*, potential adverse cumulative effects to surface water quality in combination with the effects of other reasonably foreseeable future projects or activities may occur within Michel Creek or the Elk River in the Aquatic RSA.
- Frequency: *Continuous*, the potential for adverse cumulative effects to surface water quality will be ongoing as present and proposed mine operations in the Elk Valley are anticipated to discharge to the Elk River and/or its tributaries continuously.
- Reversibility: *Reversible long-term*, the cumulative change in surface water quality resulting from present and future mining activities in the Elk Valley is anticipated to be potentially reversible once mining operations are reclaimed.
- Context: *Neutral*, the receiving environments of Michel Creek, the Elk River, and Lake Koochanusa are dynamic systems that naturally experience a wide range of flow and water chemistry conditions. The assimilative capacity of these watercourses and waterbodies may provide some natural resilience to the sediment pond discharge in combination with the effects from other present and reasonably foreseeable future projects or activities in the Aquatic RSA and therefore have the potential to return to base case conditions once the mining operations are reclaimed.

11.6.6.1.4 Determination of Significance of Residual Cumulative Effects

As discussed in Section 11.5.4.3, measurable residual Project effects for surface water quality are not predicted to occur beyond limited areas within the Aquatic LSA. The residual effects of the Project on surface water quality were found to vary with respect to magnitude and were generally limited to the upper reaches of the receiving watercourses. Accordingly, no measurable residual effects for surface water quality are predicted beyond the Aquatic LSA boundary, within the exception of potential residual effects in Michel Creek downstream of the confluence with Alexander Creek. The residual effects of the Project on surface water quality during all phases of the Project were therefore considered not significant.

The water quality model that was prepared for the Aquatic RSA includes the cumulative interactions with effects from ongoing mining operations in the Elk Valley. The results of the model indicate that the predicted change in surface water quality for the Project case is negligible to non-detectable when considering monthly median predicted concentrations during all Project phases at multiple nodes in the Aquatic RSA. Estimated mass contributions of the Project to Michel Creek are minimal and water quality in Michel Creek is expected to continue to meet Teck's permit limits in Michel Creek in lieu of a regional water quality target for this watercourse, where baseline conditions already exceed the B.C. selenium WQG of 2 µg/L.

With respect to the future case, a qualitative assessment was not possible due to the unavailability of adequate information related to the reasonably foreseeable future projects in the Aquatic RSA (i.e., proposed mine site development details, water quality predictions, etc.). However, it is understood that mitigation measures and appropriate operational practices are in place for all the current coal mines in the Elk Valley, and similarly it is expected that an appropriate mitigation strategy would be developed and implemented for the proposed future coal mining operations in order to meet the regional long-term

water quality targets outlined in the EVWQP. Additional monitoring and data sharing with other proponents will be necessary to confirm acceptability of water quality in Michel Creek.

In light of the above, and in consideration of planned mitigation and best practices, the residual cumulative effects of the Project in combination with those of other past, present, or reasonably foreseeable future projects or activities on surface water quality during all Project phases are considered not significant.

11.6.6.1.5 Likelihood and Confidence

A characterization of likelihood is not required for residual cumulative effects from Project activities that are determined to be not significant.

Confidence considers the availability and reliability of data and analytical methods used in the assessment of effects. The regional water quality model results are considered to provide a reasonable prediction of the magnitude, timing, and extent of surface water quality effects related to past and present projects and activities in the Aquatic RSA. However, water quality in Michel Creek could not be predicted using the SWWQ model and is based only on a mass comparison using limited publicly available data; therefore, the significance determination for the Project case is assigned a moderate level of confidence.

The availability of information related to reasonably foreseeable future projects and activities in the Aquatic RSA is limited, particularly for Michel Creek, and, thus, a quantitative assessment of cumulative effects on surface water quality was not possible. As such, this significance determination was assigned a moderate level of confidence for the future case.

11.6.7 Summary of Cumulative Effects Assessment

Residual cumulative effects and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 11.6-5. As indicated, there are no significant residual cumulative effects to surface water quality anticipated as a result of the Project.

Table 11.6-5: Summary of Cumulative Effects on Surface Water Quality

Residual Cumulative Effect	Project Phases	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Change in Surface Water Quality from Sediment Pond Discharge (Project Case)	<ul style="list-style-type: none"> • Operations • Reclamation and Closure • Post-Closure 	<ul style="list-style-type: none"> • Diverting clean, non-contact water away from the sediment ponds; where possible • Appropriate sizing of sediment ponds to minimize seepage losses and convey runoff during storm events • Treating water prior to discharge as required to minimize calcite formation • Limiting the mine disturbance footprint through Project design and progressive reclamation • Monitoring and adaptive management 	<p>Duration: Long-term Magnitude: Low Geographic Extent: Regional Frequency: Continuous Reversibility: Reversible long-term Context: Neutral</p>	Not Significant	Moderate
Change in Surface Water Quality from Sediment Pond Discharge (Future Case)	<ul style="list-style-type: none"> • Operations • Reclamation and Closure • Post-Closure 	<ul style="list-style-type: none"> • Working with other proponents, the provincial government, and the KNC to establish a regional monitoring program and long-term water quality targets for Michel Creek • Collaborating with other proponents to ensure these targets are met through a combination of Project-specific and regional mitigation measures 	<p>Duration: Long-term Magnitude: Low Geographic Extent: Regional Frequency: Continuous Reversibility: Reversible long-term Context: Neutral</p>	Not Significant	Moderate

11.7 Follow-up Strategy

As required by the *Canadian Environmental Assessment Act*, 2012, a follow-up program must be defined to verify the effects predictions or the effectiveness of mitigation. Therefore, a comprehensive surface water quality monitoring program will be developed and implemented to facilitate an ongoing examination of surface water quality within the receiving watercourses downstream of the Project footprint, in addition to reference sites upstream of the Project. This follow-up strategy focuses on the implementation of the monitoring and response process described in the Site Water Management Plan (Chapter 33, Section 33.4.1.8), and also the Aquatic Effects Monitoring Program (AEMP) which will include surface water quality, sediment, benthic invertebrate, and fish tissue monitoring (in fish bearing watercourses; see Chapter 33, Section 33.4.1.5). The Site Water Management Plan will include regular surface water quality monitoring at the locations identified in Table 11.7-1 and will include the collection of both in-situ field parameters and water samples for laboratory analysis. The Site Water Management Plan also describes the proposed Trigger Action and Response Plan (TARP), thresholds for action, and additional mitigation and contingency measures that can be implemented if the trigger levels are exceeded.

Table 11.7-1: Summary of Proposed Surface Water Quality Monitoring Locations

Watercourse	Location	Upstream Mine Project/Activity
Grave Creek	Upstream of Grave Creek Reservoir	<ul style="list-style-type: none"> None (reference site[s])
	Upstream of Harmer Creek	<ul style="list-style-type: none"> Crown Mountain Coking Coal Project (NWP)
	Upstream of Elk River	<ul style="list-style-type: none"> Crown Mountain Coking Coal Project (NWP) Elkview Operations (Teck)
West Alexander Creek	Main Sediment Pond	<ul style="list-style-type: none"> Crown Mountain Coking Coal Project (NWP)
	Downstream of Main Sediment Pond	
Alexander Creek	Upstream of West Alexander Creek	<ul style="list-style-type: none"> None (reference site[s])
	Downstream of West Alexander Creek	<ul style="list-style-type: none"> Crown Mountain Coking Coal Project (NWP)
	Upstream of Michel Creek	<ul style="list-style-type: none"> Crown Mountain Coking Coal Project (NWP)
Michel Creek	Downstream of Alexander Creek	<ul style="list-style-type: none"> Crown Mountain Coking Coal Project (NWP) Elkview Operations (Teck) Coal Mountain Operations (Teck) Michel Coal Project (North Coal)

NWP is committed to working with other proponents to establish a regional monitoring program in Michel Creek, as water quality in this creek has been degraded by past and present mining operations and faces additional cumulative effects from two additional proposed developments, the Crown Mountain Coking Coal Project and the Michel Coal Project. This regional approach including working with the provincial government and Ktunaxa National Council (KNC) to establish long-term water quality targets for Michel Creek, and collaborating with other proponents to ensure these targets are met through a combination of Project-specific and regional mitigation measures.

The results of the monitoring program will be used to evaluate the effectiveness of the proposed mitigation measures and determine whether additional mitigation measures or adaptive management strategies are needed.

11.8 Summary and Conclusions

The Crown Mountain Coking Coal Project (the Project) activities and components have the potential to result in adverse effects to surface water quality in both the immediate and downstream aquatic environments and could result in a residual effect to surface water quality. The thresholds for determining the significance of residual effects for the surface water quality assessment are based on the approved or working B.C. water quality guidelines for the protection of freshwater aquatic life, the CCME guidelines for the protection of freshwater aquatic life (where B.C. guidelines do not exist), and the Elk Valley long-term water quality targets (considered only for downstream effects in the Elk River and Lake Koochanusa; Teck [2014]).

To characterize the residual Project effects on surface water quality, a site-wide water and load balance model was developed to evaluate surface water quality at key locations within the Project footprint, Aquatic LSA, and Aquatic RSA under existing and proposed (i.e., mine development) scenarios. The model also incorporated proposed design mitigation measures for surface water quality.

Based on the evaluation of potential Project effects on surface water quality, potential residual effects that may remain after implementation of proposed mitigation measures include:

- Change in surface water quality from disposal of mine rock and coal rejects;
- Change in surface water quality from surface water – groundwater interactions; and
- Change in surface water quality from sediment pond discharge.

Model predictions for the Project effects assessment showed localized elevated levels of some parameters (i.e., cadmium, cobalt, selenium) in West Alexander Creek and Alexander Creek. Concentrations of these parameters showed a distinct seasonal cycle, with higher concentrations in the winter and lower concentrations during the spring freshet. Modelling suggests that there will be no measurable change to surface water quality in the Elk River or Lake Koochanusa as a result of the Project. Based on the results of the assessment, the residual effects of the Project on surface water quality related to the disposal of mine rock and coal rejects, surface water – groundwater interactions, and sediment pond discharge are considered not significant. The residual effects assessment characterization includes several potential sources of uncertainty and, therefore, this significance determination was assigned a moderate level of confidence.

A cumulative effects assessment was undertaken for the surface water quality VC because there is a possibility that potential Project residual effects may remain after the implementation of proposed mitigation measures. The cumulative effects assessment was focused on the single effect that has the potential to result in detectable concentrations of contaminants from the Project in the Aquatic RSA, namely change in surface water quality from sediment pond discharge, since residual effects resulting from a change in surface water quality from the disposal of mine rock and coal rejects or a change in surface water quality from surface water – groundwater interactions were limited to within the extent of the Project footprint. The cumulative effects assessment involved the identification of past, present, and reasonably

foreseeable future projects or activities followed by an evaluation to characterize cumulative residual effects on surface water quality in the Aquatic RSA under various temporal cases (base case, Project case, and future case). The assessment of cumulative effects under the Project case included all past and present projects/activities which have the potential to contribute to adverse cumulative effects on surface water quality, while the future case considers the potential for substantive overlapping of Project effects with those of reasonably foreseeable future projects or activities.

For the Project case, the regional water and load balance model predictions include the cumulative interactions with effects from ongoing mining operations. The results of model indicate that the predicted change in surface water quality for the Project case is negligible to non-detectable when considering median monthly concentrations of nitrate, selenium, and sulphate during all Project phases at nodes in the Elk River and Lake Koochanusa. Estimated mass contributions of the Project to Michel Creek are minimal and water quality in Michel Creek is expected to continue to meet Teck's permit limits in Michel Creek in lieu of a regional water quality target for this watercourse.

With respect to the future case, a qualitative assessment was not possible due to the unavailability of adequate information related to the reasonably foreseeable future projects in the Aquatic RSA (i.e., proposed mine site development details, proposed water treatment technologies and mitigation measure, etc.). However, it is understood that mitigation measures and appropriate operational practices are in place for all the current coal mines in the Elk Valley, and similarly it is expected that appropriate mitigation strategies will be developed and implemented for the proposed future coal mining operations.

In summary, the residual cumulative effects of the Project in combination with those of past and present projects or activities on surface water quality during all phases are considered not significant. This significance determination for the Project case was assigned a moderate level of confidence due to the uncertainties and limitations associated with the integration of the site-wide and regional water quality models and the mass contribution estimate to Michel Creek. The availability of information related to reasonably foreseeable future projects and activities in the Aquatic RSA is limited and a quantitative assessment of future cumulative effects on surface water quality was not possible. As such, this significance determination for the future case was also assigned a moderate level of confidence.

Both a Project-specific follow-up program and regional monitoring program are necessary to verify the effects predictions and the effectiveness of mitigation measures, which will improve the moderate level of confidence assigned to the prediction of residual effects (Project and cumulative) on surface water quality. The follow-up program will include the implementation of an aquatic effects monitoring program to collect surface water quality data at strategic locations within the receiving watercourses downstream of the Project footprint, in addition to a regional monitoring program in Michel Creek in collaboration with other proponents. The results of the monitoring program will be relied upon to determine whether additional mitigation measures or adaptive management strategies are needed.

11.9 References

- Bianchin, M., Martin, A., and Adams, J. (2013). *In-situ immobilization of selenium within the saturated zones of backfilled pits at coal-mine operations*. [Conference paper]. British Columbia Mine Reclamation Symposium 2013, Vancouver, B.C.
<https://open.library.ubc.ca/cIRcle/collections/59367/items/1.0042640>

British Columbia Ministry of Energy, Mines and Low Carbon Innovation. (2021). *Health, safety and reclamation code for mines in British Columbia*. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/code-review/health_safety_and_reclamation_code_apr2021.pdf

British Columbia Ministry of Energy, Mines and Low Carbon Innovation, and B.C. Ministry of Environment and Climate Change Strategy. (2022). *Technology readiness assessment interim technical guidance, version 02.00*. https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/guidance-documents/min-21_interim_guidance_on_technology_readiness_assessment.pdf

Ministry of Environment. (2014a). *Environmental mitigation policy – working document – May 13, 2014*. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-policy-legislation/environmental-mitigation-policy/em_policy_may13_2014.pdf

Ministry of Environment. (2014b). *Procedures for mitigating impacts on environmental values (environmental mitigation procedures), Version 1.0*. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-policy-legislation/environmental-mitigation-policy/em_procedures_may27_2014.pdf

British Columbia Ministry of Environment. (2015). *Technical guidance 7 Environmental Management Act: Assessing the design, size, and operation of sediment ponds used in mining*. Version 1.0. https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/assessing_design_size_and_operation_of_sediment_ponds.pdf

British Columbia Ministry of Environment. (2016). *Water and air baseline monitoring guidance document for mine proponents and operators*. <https://mines.nrs.gov.bc.ca/water-quality>

British Columbia Ministry of Environment and Climate Change Strategy. (2017). *British Columbia working water quality guidelines: Aquatic life, wildlife & agriculture*. Ministry of Environment and Climate Change Strategy.

British Columbia Ministry of Environment and Climate Change Strategy. (2019a). *British Columbia approved water quality guidelines: Aquatic life, wildlife & agriculture*. Ministry of Environment & Climate Change Strategy Water Protection & Sustainability Branch.

British Columbia Ministry of Environment and Climate Change Strategy. (2019b). *Derivation of water quality guidelines for the protection of aquatic life in British Columbia*. In MOE, Water Quality Guideline Series, WQG-06. Victoria.

British Columbia Ministry of Environment and Climate Change Strategy. (2019c). *Water quality guidelines policy*. FILE: 77510-00. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_wqg_policy.pdf

British Columbia Ministry of Environment and Climate Change Strategy. (2020a). *British Columbia working water quality guidelines: Aquatic life, wildlife & agriculture*.

British Columbia Ministry of Environment and Climate Change Strategy. (2020b). *Amended permit 107517 issued under the provisions of the Environmental Management Act*. Teck Coal Limited. <https://j200.gov.bc.ca/pub/ams/download.aspx?PosseObjectId=125887526>

British Columbia Ministry of Environment and Climate Change Strategy. (2021). *Best achievable technology assessment to inform waste discharge standards* *handout*. https://www2.gov.bc.ca/assets/gov/environment/waste-management/waste-discharge-authorization/guides/bat_assessment_steps.pdf

British Columbia Ministry of Environment, Lands and Parks. (2016). *Guidelines for designing and implementing a water quality monitoring program in British Columbia*. Version 1.0. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/guidelines_for_designing_and_implementing_a_water_quality_monitoring_program_in_british_columbia.pdf

Bureau de Normalisation du Quebec, and Standards Council of Canada. (2015). *National standard of Canada CAN/BNQ 2910-510/2015: Explosives – quantity distances*. <https://www.bnq.qc.ca/en/standardization/protection-and-safety/explosives-quantity-distances.html>

Canadian Council of Ministers for the Environment. (2014). *Canadian water quality guidelines for the protection of aquatic life*. <https://ccme.ca/en/resources/water-aquatic-life>

Canadian Environmental Assessment Agency. (2015). *Guidelines for the preparation of an environmental impact statement pursuant to the Canadian Environmental Assessment Act, 2012*. Crown Mountain Coking Coal Project, NWP Coal Canada Ltd.

Environmental Assessment Office. (2013). *Guideline for the selection of valued components and assessment of potential effects, approved September 9, 2013*. <https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/environmental-assessments/guidance-documents/eao-guidance-selection-of-valued-components.pdf>

Environmental Assessment Office (2018). *Application information requirements – Crown Mountain Coking Coal Project*. Proposed by NWP Coal Canada Ltd, April 26, 2018.

Enviromin, Inc. (2022). *Denitrification and selenium reduction in unsaturated waste rock and coal reject - Crown Mountain Coking Coal Project*.

Ferguson, K.D., and Leask, S.M. (1988). *The export of nutrients from surface coal mines*. Environment Canada Regional Program Report 87-12, March, 1988. 127 p.

Golder Associates. (2015). *Elkview Operations Baldy Ridge Extension Project - Surface water and sediment quality baseline report*.

- Government of Canada. (2022). *Proposed Coal Mining Effluent Regulations: Overview*.
<https://www.canada.ca/en/environment-climate-change/services/managing-pollution/sources-industry/proposed-coal-mining-effluent-regulations.html>
- Intergovernmental Panel on Climate Change. (2014). *Climate change 2014: Synthesis report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. <https://www.ipcc.ch/report/ar5/syr/>
- Khatri, N., and Tyagi, S. (2015). Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in Life Science*, 8:1, 23-39, doi: 10.1080/21553769.2014.933716
- Kirk, L. B., Hwang, C., Ertuna, C., Kennedy, C., and Peyton, B. (2017). *Column tests of selenium biomineralization in support of saturated rockfill design*. [Paper presentation]. 13th International Mine Water Association Congress - Mine Water and Circular Economy – A Green Congress. Lappeenranta, Finland. https://www.imwa.info/docs/imwa_2017/IMWA2017_Kirk_1191.pdf
- Maven Water & Environment, and Integrated Sustainability. 2023. *Water Mitigation Technology Readiness Memo*. Saskatoon, SK.
- McPherson, S., Baranowska, K., Duncan, L., and Ferguson, A. (2018). *Alexander Creek water quality monitoring report 2015 to 2017*. A Columbia Basin Water Quality Monitoring Project. Prepared by Lotic Environmental Ltd., Mainstreams Environmental Society, and the Elk River Alliance, for the Columbia Basin Water Quality Monitoring Project. http://cbwq.ca/wp-content/uploads/fileaway-uploads/files-reports/project-reports/elk-river-alliance/Alexander%20Creek_2015-2017_CBWQ_Final%20Report-2.pdf
- Mebane, C.A., and Schmidt, C.G. (2019). *Selenium and mercury in the Kootenai River, Montana and Idaho, 2018-2019*: U.S. Geological Survey. <https://www.sciencebase.gov/catalog/item/5d6d391fe4b0c4f70cf62b77>
- Minnow Environmental Inc. (2020). *Koocanusa reservoir monitoring program annual report, 2019*. https://www.teck.com/media/02_Koocanusa-Reservoir-Monitoring-2019-Report_w-Cover-Page.pdf
- Montana Department of Environmental Quality. (2022). *Selenium standards for Lake Koocanusa & Kootenai River rulemaking*. <https://deq.mt.gov/water/Programs/sw>
<https://deq.mt.gov/water/Programs/sw>
- Morin, K.A., and Hutt, N.M. (2009, September 20-24). *Mine-water leaching of nitrogen species from explosive residues*. [Paper presentation]. 62nd Canadian Geotechnical Conference and 10th Joint CGS/IAH-CNC Groundwater Conference, Halifax, Nova Scotia, Canada, pp. 1549-1553.
- North Coal LTD. (2021). *Michel Coal Project – North Coal*. <https://northcoal.ca/michel-coal-project/>

- Robinson, M. D., and MacDonald, R. J. (2014). *Teck Coal Limited 2013 Calcite Monitoring Program – Elk Valley Operations Summary Report*. Prepared by Lotic Environmental Ltd. 12 pp + appendices.
- SRK Consulting, Inc. (2021a). *Geochemical baseline - Crown Mountain Coking Coal Project*. SRK Project Number 1CN028.003.
- SRK Consulting, Inc. (2021b). *Groundwater technical report, Crown Mountain Coking Coal Project*. SRK Project Number 1CN028.002.
- SRK Consulting, Inc. (2021c). *Calcification assessment – Crown Mountain Project* [Memorandum]. SRK Project Number 1CN028.003.
- SRK Consulting, Inc. (2021d). *Water quality prediction model, Crown Mountain Coking Coal Project*. SRK Project Number 1CN028.004.
- SRK Consulting, Inc. (2021e). *Crown Mountain flow and water quality impact assessment modelling* [Memorandum].
- Teck Resources Limited. (2014). *Elk Valley water quality plan*. https://www.teck.com/media/2015-Water-elk_valley_water_quality_plan_T3.2.3.2.pdf
- Teck Coal Limited. (2020a). *Environmental protection notice: Notice of filing Teck Coal Ltd Elkview Operations: Saturated rock fill—Phase 2*. <https://www.teck.com/media/public-notification-srf.pdf>
- Teck Coal Limited (2020b). *Permit 107517 annual water quality monitoring report*. March 31, 2020. https://www.teck.com/media/01_Annual-WQ-Report-2019_w-Cover-Page.pdf
- Teck Coal Limited. (2020c). *Initial project description: Castle Project*. Teck Coal Limited Fording River Operations. https://www.projects.eao.gov.bc.ca/api/public/document/5ede866ae321f30021a8ed3c/download/CASTLE_IPD_Final.pdf
- Teck Resources Limited. (2019). *Elk Valley Water Quality Plan 2019 implementation plan adjustment Annex J: Alternative treatment mitigation plan*. July 2019.
- Windward Environmental, Minnow Environmental Inc., and CH2M Hill Limited. (2014). *Aquatic environment synthesis report*. Sparwood.