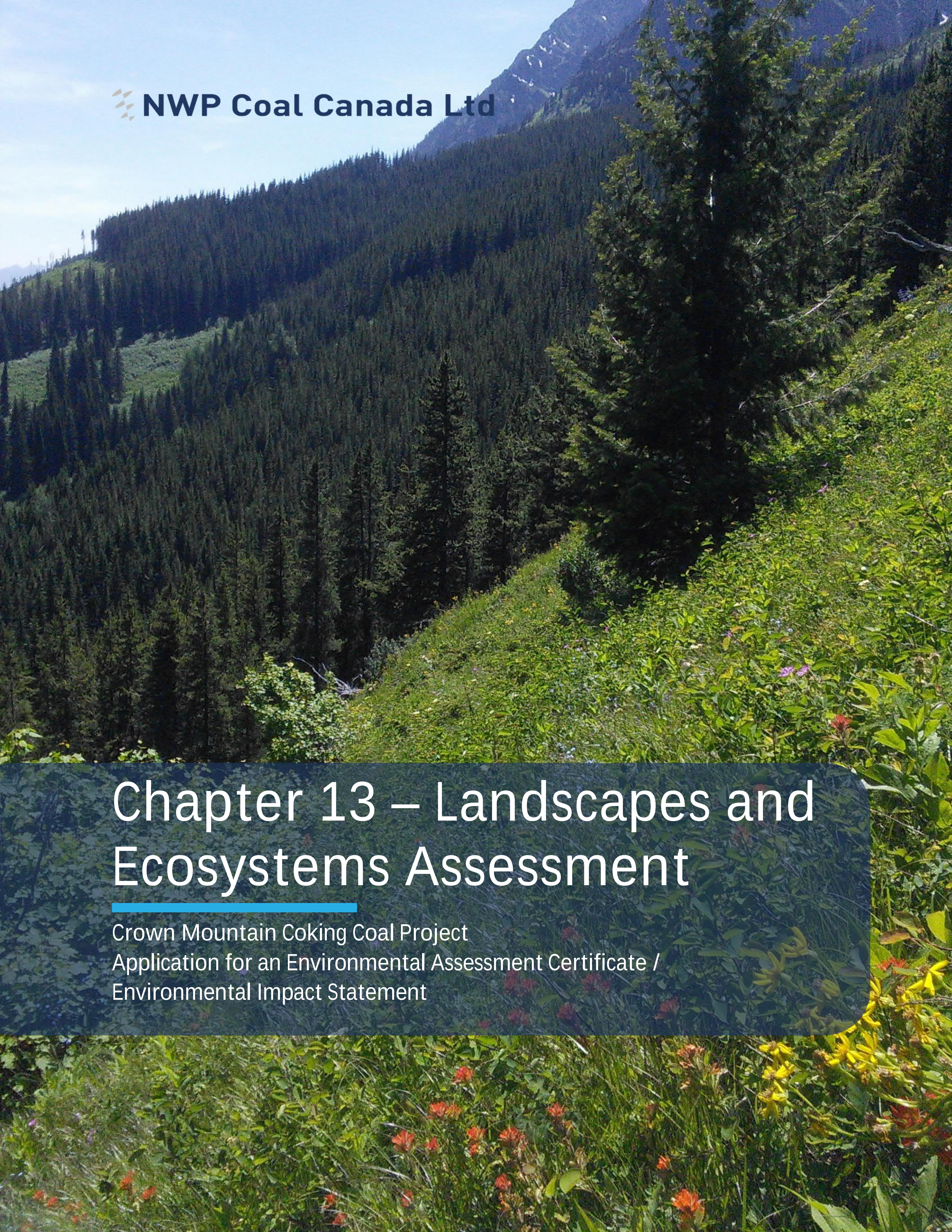

NWP Coal Canada Ltd

Chapter 13 – Landscapes and Ecosystems Assessment

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

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13. Landscapes and Ecosystems Assessment

13.1 Introduction

Terrestrial ecosystems provide habitat for wildlife species, provide essential ecosystem services to human populations, and contribute to terrestrial and aquatic biodiversity (Environment Canada, 1995; Elk Valley Cumulative Effects Management Framework [EV-CEMF] Working Group, 2018). Degradation of landscapes and terrestrial ecosystems have occurred as a result of the cumulative impacts of human activities, including industry, farming, forestry, urban development, construction of linear features, and consumption of resources (Environment Canada, 1995; EV-CEMF, 2018).

Given the complex relationships between terrestrial ecosystems, wildlife, aquatic ecosystems, and human activities, ecosystems that provide unique features on the landscape, comprise important habitat components, or demonstrate sensitivities to disturbance were identified as receptor valued components (VCs) for the Project in the Application Information Requirements (AIR; Environmental Assessment Office [EAO], 2018) and as components of the terrestrial 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). These ecosystems are:

- Avalanche Chutes;
- Grasslands;
- Riparian Habitat;
- Old Growth and Mature Forest; and
- Wetland Ecosystems.

An understanding of the potential effects to landscapes and ecosystems is important for consideration in Project design, engineering and operations planning, as well as assessment and mitigation of potential environmental effects. Landscapes and ecosystems have linkages with other VCs; these effects are primarily assessed in the following chapters:

- Chapter 6: Atmospheric Environment;

- Chapter 8: Soil and Terrain Assessment;
- Chapter 9: Groundwater Assessment;
- Chapter 10: Surface Water Quantity Assessment;
- Chapter 11: Surface Water Quality Assessment;
- Chapter 12: Fish and Fish Habitat Assessment;
- Chapter 14: Vegetation Assessment;
- Chapter 15: Wildlife and Wildlife Habitat Assessment; and
- Chapter 23: Indigenous Communities discussed in Chapters 23 through 31.

13.2 Regulatory and Policy Setting

Applicable provincial and federal legislation and guidance documents related to the management of landscapes and ecosystems are summarized in Table 13.2-1.

The Project is located within the Regional District of East Kootenay and contains areas of provincial Crown land subject to the Kootenay Boundary Land and Resource Management Plan (KBLUP; Kootenay Inter-Agency Management Committee, 1997). Approximately 7.4 million hectares (ha) of land are included within the KBLUP, which is subdivided into four land use designation categories identified as Resource Management Zones (RMZ). The land use designations indicate the general land and resource management intent for the area and comparative emphasis of conservation-oriented land-uses versus development-oriented land uses. The Project is located in the Cranbrook RMZ within the Enhanced Resource Management Zone and within the intermediate and low Biodiversity Emphasis options (Kootenay Inter-Agency Management Committee, 1997). Management objectives of the KBLUP pertaining to landscapes and ecosystems are described in Table 13.2-2.

The Elk Valley is located within the 1.24 million ha Cranbrook Timber Supply Area (TSA), and the Rocky Mountain Forest District managed by B.C. Timber Sales. B.C. Timber Sales (BCTS) is an independent organization within the British Columbia (B.C.) Ministry of Forests, Lands, and Natural Resource Operations and Rural Development (FLNRORD). The Elk Valley is within the Kootenay Business Area for B.C. Timber Sales (composed of Cranbrook and Invermere TSAs), and the BCTS has Forest Stewardship Plan #601 currently in place for the region. The current applicable Forest Stewardship Plan details how the operations of BCTS are consistent with government objectives. Land base designated for protection of riparian reserves and old growth values is excluded from harvest.

As part of the Provincial Cumulative Effects Framework, the Elk Valley Cumulative Effects Management Framework (EV-CEMF) aims to assess the historic, current, and potential future conditions of selected VCs and to support natural resource management decisions within the region (Province of British Columbia [B.C.], 2020). The purpose of EV-CEMF is to develop an approach to understand cumulative effects on the environment from various industries and natural events in the Elk Valley. Terrestrial ecosystem valued components assessed under EV-CEMF include riparian habitat and old growth and mature forest (Province of B.C., 2020). Riparian habitat was selected as a VC for EV-CEMF because riparian areas have high biodiversity, provide critical habitat for wildlife, and moderate flooding events (Davidson et al., 2018). Old forests were selected as a VC for EV-CEMF because of their high ecological, social, economic, and cultural values (Holmes et al., 2018). Mature forests were included in some EV-CEMF analyses due to their potential old forest recruitment value.

Table 13.2-1: Regulatory Considerations and Guidance Documents Relevant to Landscapes and Ecosystems

Legislation/Guideline Name	Year	Description
Federal Legislation		
Migratory Birds Convention Act	2003	Prohibitions under the Migratory Birds Convention Act (MBCA) (1994) provide legislative protection to migratory birds listed under its Schedule 1 and their nests.
Species at Risk Act	2002	Protects wildlife species (plants and animals) in Canada from decline or disappearance. Aids in the recovery of species that are extirpated, threatened, or endangered. Manages species of special concern, and provides protection for critical habitat for species at risk. The management of terrestrial landscapes and ecosystems or ecosystem features considered critical to survival of protected wildlife (i.e., critical habitat) will be influenced by their presence.
Fisheries Act	1985, amended 2019	Establishes a framework for the management of fisheries resources and conservation of fish, including prohibiting the death of fish by any means other than fishing, the harmful alteration, disruption, and destruction (HADD) of fish habitat, and the release of deleterious substances, among other requirements. May have implications for wetlands that support protected fish species or riparian habitat along watercourses.
Provincial Legislation		
Environmental Management Act	2003	Regulates waste discharge, hazardous waste, pollution, and contaminated sites remediation.
Riparian Areas Protection Act (formerly the Fish Protection Act)	1997, Retitled in 2016	Protects fish and fish habitat, including riparian areas, and indirectly protects wetlands that constitute or contribute to fish habitat.
Riparian Areas Protection Regulation	2004	Protects the many and varied features, functions, and conditions vital to aquatic health in riparian areas and wetlands that constitute or contribute to fish habitat.
Seeds Act	1985	Regulates seed sold, imported, and exported in Canada and their associated grade, also requires that seed in Canada is free of prohibited noxious weeds and ensures that standards of purity are met.
Water Sustainability Act	2016	Creeks, rivers, and swamp, marsh, and fen wetlands are included under the definition of "stream" in the Water Sustainability Act (WSA). Bog and shallow water wetlands are excluded from the definition. The WSA is intended to conserve water for B.C. residents now and in the future by managing the flow, use, and diversion of water resources in B.C.

Legislation/Guideline Name	Year	Description
Water Protection Act	1996	Protects the province's water and, indirectly, riparian areas and wetlands, by reconfirming B.C.'s ownership of both surface and groundwater, limiting bulk water removal, and not permitting large-scale water diversion amongst watersheds and outside of B.C.
Forest and Range Practices Act	2002	Provides guidance on riparian management around fish bearing streams, lakes, and wetlands, and on the size of harvestable forest and allowable harvesting rates. Indirectly affects wetland management.
Invasive Plants Regulation	2004	Identifies species of invasive plants in B.C.
Private Forest Managed Land Act and Regulation	2003	Supports landowners of forested lands to manage property for long-term forest production and meet legislated objectives for public environmental values, including riparian areas and critical wildlife habitats.
Weed Control Act	1996	Sets out requirements for land occupiers to control noxious weed species and provides the province legislation to plan, implement, and enforce a weed control program.
Weed Control Regulation	1985	Outlines plant species designated as noxious weeds in B.C.
Mines Act	1996	Includes permitting, reclamation, and protection of and mitigation for damages to watercourses, and may therefore apply to the landscapes and ecosystems VCs.
Guidelines and Guidance Documents		
Canadian Biodiversity Strategy	1995	Improves coordination of efforts aimed at conserving and sustainably using biological resources across Canada.
An Invasive Alien Species Strategy for Canada	2004	National strategy to protect Canada's native biodiversity and domesticated plants from invasive species.
Elk Valley Official Community Plan	2014	Provides local policies and best management practices for the protection of sensitive features on the landscape, including riparian areas and some grasslands and avalanche chutes.
Federal Policy on Wetland Conservation	1991	Federal policy document that outlines the coordinated federal approach to wetland conservation with the goal to "promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future". It strives to achieve a goal of "no net loss of wetland functions" on federal land and waters.
The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers	1996	Guidance document for federal land managers to meet commitments outlined in the Federal Policy on Wetland Conservation (1991).

Legislation/Guideline Name	Year	Description
B.C. Water Quality Guidelines (B.C. WQG; Approved and Working)	2019; 2020	Short term maximum "acute" and long term "chronic" comparison values for surface water quality, for the protection of aquatic organisms. Indirectly applies to wetlands in which these organisms occur.
Wetland Ways: Interim Guidance for Wetland Protection and Conservation in British Columbia	2009	Outlines guidance to protect and maintain wetland ecosystems in B.C.
Forest Practices Code Riparian Management Area Guidebook	1995	Provincial guidance document that provides objectives for management zones around riparian and wetland areas.
Invasive Species Strategy for British Columbia (2018 - 2022).	2017	Provides a strategic framework for improved terrestrial and aquatic invasive species management in B.C.
Best Practices for Managing Invasive Plants Along Roadsides: A Pocket Guide for British Columbia's Maintenance Contractors	2019	The Ministry of Transportation and Infrastructure (MOTI) has developed invasive plant best practices for roadside maintenance operations. If applied, these best practices can limit the introduction and spread of invasive plants to wetlands and riparian areas along roads.
Health, Safety and Reclamation Code for Mines in British Columbia	2021	Protects workers and the public from undue health and safety risks associated with mining activities and outlines provisions to minimize risks to health, safety, and the environment as a result of mining.

Table 13.2-2: Management Objectives of the Kootenay Boundary Pertaining to Landscapes and Ecosystems

Ecosystem-related Resource	Management Objectives
Ecosystem Health - General	• Maintain healthy, functioning ecosystems that are essential to the diversity, abundance, distribution and life histories of fish, wildlife, vegetation and water resources. • Protect, conserve, and reduce risks to rare, threatened and endangered terrestrial and aquatic species. • Maintain the quality, integrity and connectivity of grassland habitats so as to support the associated red and Blue-listed species. • Maintain wildland attributes necessary for ecosystem health through coordinated access planning for resource development and associated activities.
Ecosystem Health - Terrestrial	• Maintain the regional diversity and a suitable abundance of native terrestrial species of plants and animals, and the ecosystems upon which they depend. • Maintain the diversity and a suitable abundance of wide-ranging carnivore populations and the ecosystems upon which they depend. • Maintain the diversity and a suitable abundance of ungulate species and the habitats on which they depend. • Maintain and diversify the recreational value of wildlife.
Aquatic Ecosystem Health	• Protect and conserve aquatic ecosystem functions and processes. • Maintain water quality, quantity and timing of flow at appropriate levels in community and domestic use watersheds.

Ecosystem-related Resource	Management Objectives
Rangeland Ecosystems	• Maintain highly diverse and contiguous rangelands. • Manage rangeland ecosystems within the limits of their sustainable carrying capacity. • Restore rangeland by reducing current and historic forest ingrowth. • Maintain and restore the integrity of riparian areas. • Ensure all rangeland dependent rare species are identified and maintained in a viable state.
Ungulate Winter Range	• Maintain the quality, integrity and connectivity of grassland habitats so as to support the associated red and Blue-listed species.
Access Management	• Recognize environmental conservation and other land use and resource management objectives when making decisions on the disposition of Crown land for settlement and other purposes. • Prevent or reduce conflicts between resource access developments and sensitive environmental, recreational and cultural heritage resource values and areas.

No federal or provincial legislation addresses wetlands, grasslands, and avalanche chutes specifically. A federal policy document (Government of Canada, 1991; Lynch-Steward et al., 1996) provides guidelines for wetland conservation on federal land (Table 13.2-1). Legislation for other groups of organisms may indirectly address wetlands used by organisms protected under those Acts (i.e., Species at Risk Act [2002]; Migratory Birds Convention Act [1994]; and Fisheries Act [1985; amended 2019]). Legislation and guidelines that focus on fish (e.g., Riparian Areas Protection Regulation) provide indirect protection for some wetland types or are focussed on other groups such as fish.

13.3 Scope of the Assessment

13.3.1 Valued Components and Measurement Indicators

Five representative terrestrial ecosystem types were identified as receptor VCs for the Project in the provincial AIR (EAO, 2018): avalanche chutes, grasslands, riparian habitat, old growth and mature forest, and wetland ecosystems. The list of landscapes and ecosystems receptor VCs assessed does not differ from the Project AIR (EAO, 2018). Measurement indicators for each landscape and ecosystem VC are summarized in Table 13.3-1. Details on each ecosystem type and rationale for inclusion as VCs are provided in the following subsections.

Table 13.3-1: Measurement Indicators and Effects Pathways for Landscape and Ecosystem Valued Components

Valued Component	Measurement Indicators	Effects Pathways
Avalanche Chutes	• Ecosystem abundance and distribution relative to baseline conditions; and • Compositional and structural changes of the ecosystem through assessment of species richness, presence/absence of sensitive/listed plant species, and presence/absence of invasive species	VCs or VC groups identified as effects pathways for avalanche chutes include: • Soil quantity and quality; • Terrain; • Groundwater quality and quantity; and • Air quality.
Grassland Ecosystems	• Ecosystem abundance and distribution relative to baseline conditions; and • Compositional and structural changes of the ecosystem through assessment of: o species richness; o presence/absence/relative abundance of common native species; o presence/absence/relative abundance of sensitive/listed plant species; o presence/absence/relative abundance of invasive species; and o structural stage information.	VCs or VC groups identified as effects pathways for grassland ecosystems include: • Soil quantity and quality; • Terrain; • Surface water quantity; • Surface water quality; and • Air quality.
Riparian Habitat	• Ecosystem abundance relative to baseline conditions; and • Compositional and structural changes of the ecosystem	VCs or VC groups identified as effects pathways for riparian habitat include: • Soil quantity and quality; • Terrain; • Groundwater quantity and quality; • Surface water quantity; • Surface water quality; and • Air quality.
Old Growth and Mature Forest	• Ecosystem abundance and distribution relative to baseline conditions; and • Compositional changes of the ecosystem measured through items such as canopy closure, changes in seral stage age class, distance of habitat edge, and type of old growth (as recommended by the EV-CEMF).	VCs or VC groups identified as effects pathways for old growth and mature forest include: • Soil quantity and quality; • Terrain; • Groundwater quality and quantity; and • Air quality.
Wetland Ecosystems	• Ecosystem abundance and distribution relative to baseline conditions, including identification of red and Blue-listed communities where applicable (e.g., amount of ecosystem present, connectivity of ecosystem, patch size);	VCs or VC groups identified as effects pathways for wetland ecosystems include: • Groundwater quantity and quality; • Surface water quantity;

Valued Component	Measurement Indicators	Effects Pathways
	• Compositional and structural changes of the ecosystem through assessment of: o species richness; o presence/absence/relative abundance of common native species; o presence/ absence/ relative abundance of sensitive/ listed plant species; o presence/ absence / relative abundance of invasive species; and o structural stage information; o Changes in wetland function as they relate to migratory birds and species at risk; and o Presence/absence of fish.	• Surface water quality; and • Air quality.

Avalanche Chutes

Avalanche chutes are features that are common to mountain ecosystems maintained by frequent snow, rock, and ice avalanches (Quinn and Phillips, 2000). Snow avalanches are complex phenomena that depend on physical attributes of the snow, terrain, and weather. Topography is a key determinant in the frequency, intensity, and timing of avalanches (Patten and Knight 1994; Malanson and Butler, 1984). The vegetation structure in avalanche chutes is characterized by large tree (especially conifer) suppression and the persistence of disclimax communities dominated by low herbaceous vegetation and/or deciduous shrubs, with small bole diameter conifers persisting in shrubby form (Quinn and Phillips, 2000).

Avalanche chutes provide important foraging habitat for a number of wildlife VCs during the spring and summer months (e.g., bighorn sheep [Ovis canadensis], mountain goat [Oreamnos americanus], and grizzly bear [Ursus arctos horribilis]) and are characterized by grass, forbs, and shrub species. Avalanche chutes occur in the vicinity of the Project, and as such have the potential to be impacted by direct and indirect effects of the Project.

Grasslands

Grasslands are defined for the purposes of this assessment as the grassland group of non-forested ecosystems (MacKenzie, 2012; MacKillop et al., 2018), which include grasslands, brushlands, alpine grasslands, and alkaline/saline meadows. Grasslands include ecosystems in which conditions are too dry for forest establishment as a result of semi-arid climate, or dry and warm sites within otherwise forested areas (MacKillop et al., 2018). Grassland, brushland, shrub-steppe, and alkaline/saline meadow ecosystems are generally considered at-risk ecosystems in the East Kootenay region because they are naturally uncommon and threatened by multiple factors, including development, overgrazing, invasive alien plant species, off-road vehicle use, and loss of natural fire patterns (MacKillop et al., 2018). Grasslands provide important habitat diversity in areas dominated by forests, including valuable forage for livestock and important habitat for grazing ungulates. They also frequently provide habitat for at-risk species and species of concern. Grassland ecosystems occurring within the vicinity of the Project have the potential to be directly or indirectly as a result of Project activities, and as such, this ecosystem type was selected as a VC.

Riparian Habitat

Riparian habitat is defined as the transition zone between the aquatic environment (e.g., rivers, streams, lakes, and wetlands) and upland ecosystems and provide important habitat for terrestrial and aquatic species (Province of B.C., 1995). Riparian habitats are often biologically diverse and may provide numerous ecosystem services, including removal of excess nutrients and suspended sediments, input of nutrients to waterbodies, temperature regulation of waterbodies, and providing habitat to terrestrial and aquatic wildlife. Riparian ecosystem vegetation is frequently more species-rich than adjoining upland ecosystems (Goebel et al., 2003). Riparian habitats often function as wildlife movement corridors (Hauer et al., 2016). Due to their occurrence in valley bottom locations, these habitats are also potentially subject to human disturbance.

The EV-CEMF (Davidson et al., 2018) has identified riparian habitat as a VC (Province of B.C., 2020). Given that the Project may result in direct and indirect impacts to riparian habitat, this ecosystem was selected as a VC for the Project.

Old Growth and Mature Forest

For the purposes of this assessment, the definitions for old growth and mature forest are those used by the Government of B.C. (B.C. Ministry of Forests and Range and B.C. Ministry of Environment [B.C. MOE], 2010) and modified in the Kootenay Boundary Higher Level Plan Order (KBHLPO; Forest and Range Practices Act, 2002). Mature forest is defined by the B.C. Ministry of Forests and Range and B.C. MOE (2010) as the following:

> Trees established after the last stand-replacing disturbance have matured; a second cycle of shade-tolerant trees may have become established; shrub and herb understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years for (biogeoclimatic [BCG] units of the study area) (p. 23).

Under the KBHLPO, mature forest is defined to between 100 to 120 years old depending on the biogeoclimatic zone (Forest and Range Practices Act, 2002). Old forest is defined by the B.C. Ministry of Forests and Range and B.C. MOE (2010) as the following, which is the definition used in the EV-CEMF (2018) evaluation of old growth and mature forests:

> Stands of old age with complex structure; patchy shrub and herb understories are typical; regeneration is usually of shade-tolerant species with composition similar to the overstorey; long-lived seral species may be present in some ecosystem types or on edaphic sites. Old growth structural attributes will differ across biogeoclimatic units and ecosystems…time since stand replacing disturbance is generally 140 – 250 years for biogeoclimatic units [of the study area] (pg 23-24).

Due to their structural complexity, large tree size and stable micro-climatic conditions, old (and mature, to a lesser extent) forests are often more biologically diverse in organisms including fungi, bryophytes, lichens, vascular plants, molluscs, amphibians, reptiles, mammals, and birds than other forest stages (Carey and Johnson, 1995; Corn and Bury, 1989; ECONorthwest, 2006; Spies and Franklin, 1996). Specific features of old growth and mature forests that provide habitat (including food) for wildlife include: large, decaying fallen trees (i.e., coarse woody debris [CWD]), large decaying standing dead trees (i.e., snags), large live trees, and well-developed understories (Aubry and Raley, 2002; Carey, 1995; Farris and Zack, 2005). Snags and CWD increase forest structure complexity, which results in greater foraging, roosting, security and/or thermal cover, denning, and/or nesting opportunities for wildlife (Farris and Zack, 2005; Resource Inventory Standards Committee [RISC], 1999) including other VCs such as Pileated Woodpecker (Dryocopus pileatus; Carey et al., 1991; Harestad and Keisker, 1989) and American marten (Martes americana; Bonar, 2000). Several wildlife VCs identified for the Project are seasonally reliant on old growth and mature forests, such as western toad (Anaxyrus boreas; Browne and Paszkowski, 2010), wolverine (Gulo gulo), and moose (Alces alces, Krebs et al., 2007; Poole and Stuart-Smith, 2006; RISC, 1999; Weir and Lofroth, 2004). Given that old growth and mature forest has been impacted by previous activities in the Elk Valley (e.g., mining, agriculture, forestry), and that the Project may indirectly and directly impact the amount and accessibility of old growth and mature forest, this ecosystem was identified as VC for the Project.

Wetland Ecosystems

Wetland ecosystems were selected as a VC for which potential effects resulting from the Project will be assessed due to the ecological functions and cultural value they provide, including the potential to support rare and sensitive plant communities and species. Wetlands contribute to biodiversity by providing habitat for a variety of terrestrial and freshwater species, including sensitive amphibian species such as the western toad, and a variety of migratory bird species, particularly waterfowl in open and shallow water, shorebirds in marsh, and songbirds in wetland riparian habitat (e.g., Ruby-crowned Kinglet [Regulus calendula], Yellow-rumped Warbler [Setophaga coronata], and Northern Waterthrush [Parkesia noveboracensis]). Wetlands also maintain and improve water quality through their ability to filter pollutants and sediments.

13.3.2 Indigenous and Stakeholder Information

NWP engaged with Indigenous groups and conducted consultation with public stakeholders and government agencies. A summary of all consultation and engagement activities undertaken to date is presented in Chapter 4. A summary of consultation feedback specific to landscapes and ecosystems is presented in Table 13.3-2. Indigenous and stakeholder consultation feedback received was used to inform the wetland ecosystems baseline assessment, evaluate karst potential in the Project area, and inform the development of the Ecological Restoration Plan.

13.3.3 Assessment Boundaries

13.3.3.1 Spatial Boundaries

Four spatial boundaries were considered in the landscapes and ecosystems assessment: the Project footprint, the Landscapes and Ecosystems Local Study Area (LSA), the Terrestrial LSA, and the Landscapes and Ecosystems Regional Study Area (RSA). As detailed in Chapter 5, Table 5.3-2, the spatial boundaries for the landscapes and ecosystems VCs have changed from the study areas presented in the AIR. A discussion on the spatial boundaries used in the assessment is provided below.

Table 13.3-2: Summary of Consultation Feedback on Landscapes and Ecosystems

Topic	Feedback Received*: IG	G	P/S	O	Consultation Feedback	Feedback Source	Response or Actions Identified
Wetland fish presence and bioaccumulation		✓			Comment on areas where potential bioaccumulation in fish could be occurring within the Local Study Area.	Comment received from the Impact Assessment Agency of Canada (IAAC) during the June 6, 2019 Aquatics Working Group Meeting.	Potential bioaccumulation in fish is considered to only be relevant in streams and wetlands that are confirmed to be fish bearing and have the potential to be impacted by the Project. These areas are also considered a priority for monitoring potential bioaccumulation effects during operations. A wetland fish survey was completed in 2019. See Chapter 12 for details.
Reclamation and mine closure and plant assemblages to be restored				✓	Question on plant assemblages to be used in reclamation.	Question from WildSight during a Project discussion and terrestrial modelling presentation September 10, 2020.	Mine closure planning and ecological restoration will take a native species and ecosystem-based approach. The goal of site reclamation is to promote ecosystems that are valuable for wildlife species. Rough fescue, and other native grasses, and native forbs will be used at sites in higher elevations. Low-lying areas where former pits would have been will be used for wetland ecosystems. Sedges are highly successful in disturbed soils and are anticipated to work well in disturbed areas.
Wildlife Working Group Meeting (federal agencies)		✓			Comment on importance of explicitly stating in the Application/Environmental Impact Statement (EIS) the distance of the Project to wetland ecosystems.	Impact Agency of Canada, February 22, 2018 Wildlife Working Group Meeting with federal agencies.	The proximity of wetland ecosystems to the Project is presented in Section 13.4.2.6, Table 13.5-23.

Topic	Feedback Received*:				Consultation Feedback	Feedback Source	Response or Actions Identified
	IG	G	P/S	O			
Inclusion of karst as a VC	✓				The distribution and abundance of karst formations in the Elk Valley are not well documented; however, Ktunaxa Nation Council (KNC) has expressed interest in the Project's potential effects on karst. Further, other recreational stakeholders and commercial tourism operators are known to access karst formations in the Fernie to Crowsnest Pass region.	Comment received from the KNC on November 23, 2020 as a follow-up to the October 21, 2020 Terrestrial Effects Working Group Meeting.	Karst potential has been incorporated into baseline data collection using the following sources and analysis: • Overlay of provincial mapping for karst; • Review of the drilling campaigns' geophysical logs; • Review of geochemical analysis of the rock and; and • Review of detailed light detection and ranging (LiDAR) data of the proposed footprint and adjacent areas shows potential karst cavern outcrops. The following VCs include Karst in their analysis: • Terrain Assessment (Chapter 8, Section 8.4.3.2); and • Groundwater intermediate valued component (Chapter 9, Section 9.3.4); and • The at-risk bat model incorporates karst potential (Chapter 15, Appendix 15-C).

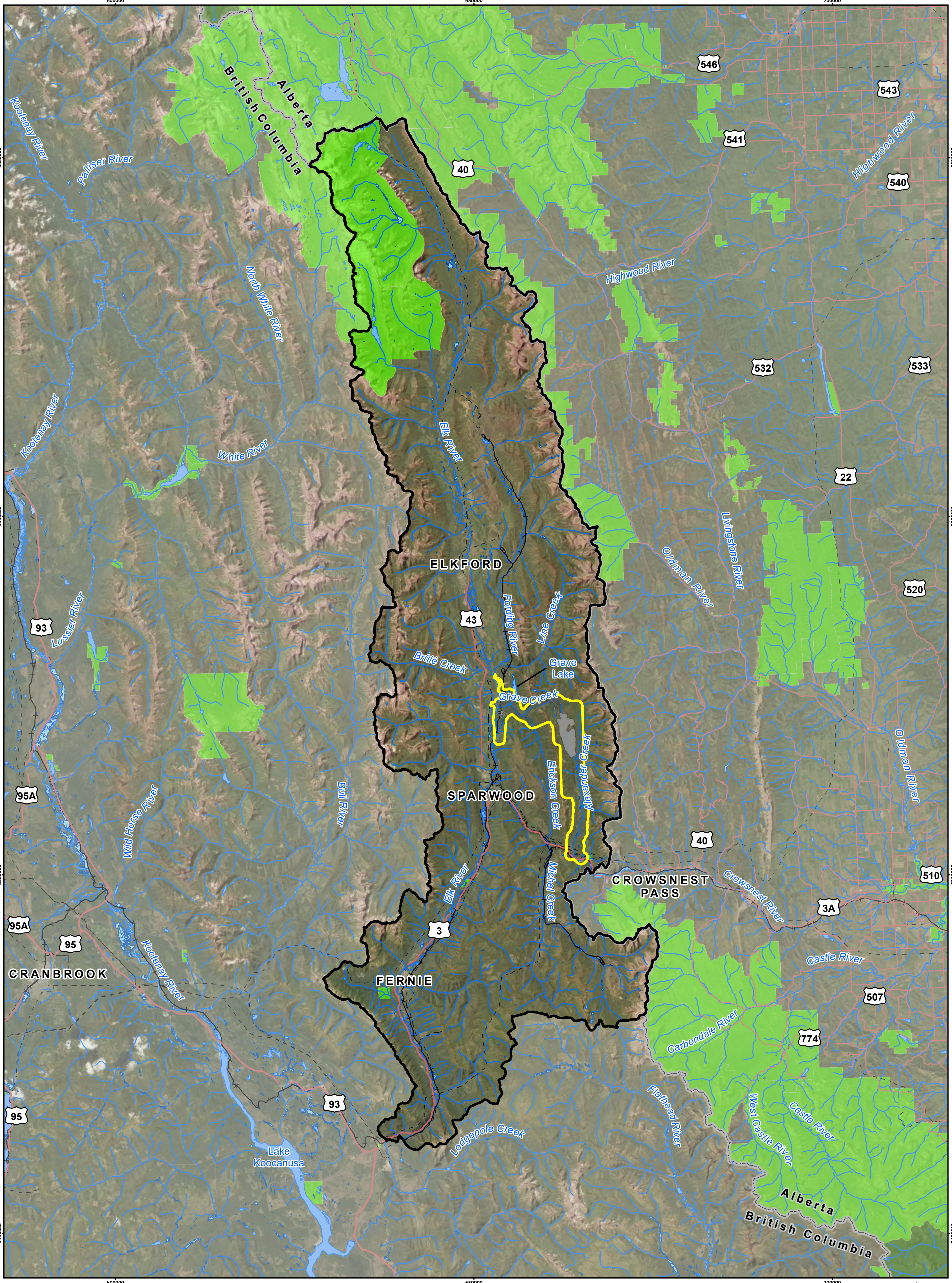
Note:
* IG = Indigenous Group (group specified in feedback source); G = Government (provincial or federal agencies); P/S = Public/Stakeholder (Interest group, local government, tenure and license holders, members of the public); O = Other

The Project footprint is the area of physical disturbance associated with the Project and encompasses all anticipated Project components, both temporary and permanent, covering approximately 13 km^2 or 1,283 ha (Figure 13.3-1). 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 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). All watersheds in the Project footprint are located on the western side of the Continental Divide. The Project footprint is located within portions of the Grave Creek and Alexander Creek watersheds. 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 Landscapes and Ecosystems LSA corresponds to the area assessed during several of the Project baseline studies (e.g., Terrestrial Ecosystem Mapping [TEM], listed plants and ecological communities, limber pine, and whitebark pine). The boundary of the Landscapes and Ecosystems LSA corresponds to a 1 km buffer around the Project footprint and coal licenses (Figure 13.3-1), covering an area of approximately 12,886 ha. The Landscapes and Ecosystems LSA can be thought of as the “zone of influence” of the Project on avalanche chutes, grasslands, riparian habitat, and old growth and mature forests.

Specific to the assessment of wetland ecosystems as a result of the Project, the Terrestrial LSA was used as the spatial boundary for which to evaluate potential impacts that may occur as a result of the Project. The Terrestrial LSA includes the area surrounding the Project footprint that may experience changes at an ecosystem level, both indirectly and directly, and covers 24,221 ha. The Terrestrial LSA can be thought of as the “zone of influence” of the Project on wetland ecosystems. The Terrestrial LSA was used as the spatial boundary for wetlands as wetlands within this area were evaluated as part of baseline surveys and completed in tandem with other terrestrial baseline projects (e.g., bird community, amphibians). The Terrestrial LSA considers watercourses that influence wetland development and persistence, including Grave Creek, West Alexander Creek, Alexander Creek, and Harmer Creek and as such, includes the watersheds of these watercourses. Erickson Creek was not included in the Terrestrial LSA for the wetland ecosystem surveys as it is outside the potential Project area of influence.

The Landscapes and Ecosystems RSA, approximately 350,919 ha in size, mainly coincides with the assessment area used by the Elk Valley Cumulative Effects Management Framework (EV-CEMF; Province of B.C., 2020) and includes important landscape features known to facilitate wildlife movement (e.g., the Elk River drainage), including mountain passes on the Continental Divide such as Deadman and Racehorse Passes. The Landscapes and Ecosystems RSA also includes all operating and proposed mines within the Elk Valley, and several developed areas, including the municipal boundaries of Sparwood, Elkford, and Fernie. The Landscapes and Ecosystems RSA is the area used for the cumulative effects assessment and is consistent with the area used to monitor and manage cumulative effects through the EV-CEMF. Although the existing conditions and potential Project effects on wetlands were assessed using the Terrestrial LSA, cumulative effects of the Project were assessed using the Landscapes and Ecosystems RSA.



Crown Mountain Coking Coal Project

Figure 13.3-1
Landscapes and Ecosystems Regional and Local Study Areas

LEGEND

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

0 10 20
Kilometres

Scale 1:500,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada.
Imagery Provided By ESRI.

Map Created By: RB/LMM
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

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Project: 12-6231
Status: FINAL
Date: 2022-01-11

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13.3.3.2 Temporal Boundaries

Temporal boundaries include the time periods during which the Project is anticipated to result in potential effects on VCs (EAO, 2013a). 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 (Table 13.3-3). Additional details on the Project phases and activities are provided in Chapter 3.

Table 13.3-3: Temporal Boundaries for the Landscapes and Ecosystems 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

13.3.3.3 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 13.2-1, the Landscapes and Ecosystems LSA, Terrestrial LSA, and Landscapes and Ecosystems RSA occur within the resource management area boundaries of Fisheries and Oceans Canada's (DFO) Pacific Region and the Ministry of FLNRORD Rocky Mountain District in Kootenay-Boundary Region, Ministry of Environment and Climate Change Kootenay Region 4, and Ministry of Energy, Mines and Low Carbon Innovation Southeast Region.

13.3.3.4 Technical Boundaries

Technical boundaries represent constraints imposed on the assessment due to limitations in the ability to predict the effects of the Project (EAO, 2013a). Technical boundaries correspond to Project boundaries used as data sources for assessments such as EV-CEMF, which forms the bounds of the Landscapes and Ecosystems RSA and provides data for the riparian habitat and old growth and mature forest VCs. The boundary of Crown land forms a technical boundary for the old growth and mature forest VC, as forest age inventory information is lacking for private lands.

Avalanche chute, grassland, riparian habitat, and old growth and mature forest VCs of the landscapes and ecosystems assessment were mapped in the Landscapes and Ecosystems LSA using the Project TEM (Appendix 13-A; KES, 2020a), whereas corresponding mapping for the Landscapes and Ecosystems RSA was conducted through interpretation of the Predictive Ecosystem Mapping (PEM) prepared for the Cranbrook TSA (FLNRORD, 2014a). Given the differences in methods used to classify ecosystems within the Landscapes and Ecosystems LSA and RSA, there is potential for variation to exist, particularly where comparing the Project footprint's overlap with landscapes and ecosystems VCs, as the exact areas may differ between the two datasets, strictly based on the differences in the methods used to prepare the mapping data.

Additionally, not all areas mapped as landscapes and ecosystems VCs within the Project TEM (Appendix 13-A) are represented in polygons attributed to a single site series. For example, an ecosystem polygon may be dominated by an unrelated upland site series; however, codominant or subdominant proportions of the delineated polygon area may be attributed to riparian habitat related site series (i.e., floodplains, 110, 111). The total area of overlap with landscapes and ecosystems VCs was interpolated by multiplying the total polygon area by the estimated proportion attributed to the applicable site series (described in the baseline conditions for each landscapes and ecosystems VC). Although this method is reasonable for the quantification of potential effects associated with the Project, it may not accurately reflect the precise location and delineated extent of all areas of impact. Site-specific mitigation planning will be based on refined mapping conducted during the detailed design stage of development.

Finally, species-, population-, and community-specific responses to changes in environmental conditions are inherently complex, vary over space and time, and therefore are outside of the scope of this assessment. Where data are insufficient for the quantification of a VC, the VC and associated potential effects shall be characterized qualitatively.

13.3.3.4.1 Avalanche Chutes

A technical boundary for avalanche chutes in the Landscapes and Ecosystems LSA exists due to the TEM being unable to reliably distinguish between willow and alder dominated map units and missing fine scale variability in vegetation due to patchy differences in soil conditions. The Landscapes and Ecosystems RSA avalanche track areas, generated from the Cranbrook TSA PEM (ROKB, 2014a), are based on a different approach to mapping than utilized in the Landscapes and Ecosystems LSA and do not differentiate the dry and lush herb dominated portions of the avalanche chutes.

13.3.3.4.2 Old Growth and Mature Forests

The Project TEM (Appendix 13-A) provides the estimated structural stage of component site series, but does not provide the estimated time since the last stand replacing disturbance event (i.e., stand age). Consequently, any change in abundance of old growth and mature forest in the Landscapes and Ecosystems LSA would exhibit a worst case scenario, disregarding potential recruitment from other younger stands as they would age over the life of the Project, though this factor is accounted for in the modelling conducted.

13.3.3.4.3 Wetland Ecosystems

Research, inventory, and classification of wetlands in the Elk Valley is limited. Existing information used to evaluate effects to wetland ecosystems includes the wetland ecosystem baseline data collection, the TEM, and related aerial imagery. The assessment of potential effects to wetland ecosystems is based on the Terrestrial LSA and wetlands surveyed as part of the baseline data collection (Dillon Consulting Limited, 2020; Appendix 13-B). These data are anticipated to be sufficient to evaluate Project-related effects to wetland ecosystems; however, due to constraints in field sampling (e.g., inaccessibility in high elevation areas), data collection in some areas of the Terrestrial LSA was not completed, resulting in potential limitation of data coverage of wetlands within the Terrestrial LSA.

13.4 Regional and Local Overview

The Project is located in the Elk Valley within the front ranges of the southern Rocky Mountains in south-eastern B.C. The Elk Valley stretches more than 180 km from the mouth of the Elk River at Lake Koocanusa in the south, north to its headwaters in Elk Lakes Provincial Park near the Continental Divide along the

B.C.-Alberta border (EV-CEMF, 2018; George et al., 1987). The Elk Valley forms part of the Continental Ranges of the Rocky Mountains. Elevations in the Terrestrial LSA range from 1,170 metres above sea level (m asl) along the Elk River west of Grave Lake up to above 2,700 m asl along the Continental Divide at the northeast corner of the Terrestrial LSA (Figure 13.3-1). Erickson Ridge (2,480 m asl) is a major north-south limestone ridgeline from the Kootenay Group within the Terrestrial LSA that separates the Project from Teck's Elkview Operations to the southwest. Immediately north of Erickson Ridge, across the east-west flowing Grave Creek is Sheep Mountain (2,460 m asl), of the same geologic origin. Sheep Mountain parallels Grave Lake as its western shore and is connected via a north-south ridgeline to Mount Salter (2,530 m asl) immediately south of the east-west Line Creek valley.

The East Kootenay overlaps with the traditional territory of the Ktunaxa Nation and Shuswap Indian Band. Indigenous peoples have inhabited this area since the last glaciation, at least 10,000 years ago, and managed the land, plants, and wildlife through periodic burning of dry ecosystems (MacKillop et al., 2018). Land use in the East Kootenay changed drastically with the introduction of the railway through Crowsnest Pass in 1898 and subsequent development and changes in land use relating to settlements, mining, forestry, cattle ranching and changes fire frequency through suppression. Native plant communities at low elevations were particularly hard hit (Eastham, 1949 in MacKillop et al., 2018).

Key watercourses in the Project footprint, local, and regional study areas include the Elk River, Michel Creek, Alexander Creek, West Alexander Creek, Harmer Creek, and Grave Creek (Figure 13.3-1). Waterbodies in the immediate vicinity of the Project include Grave Lake, Harriet Lake, Mite Lake, and Barren Lake. For more details on the watersheds, refer to Chapter 10.

Current land uses within the Landscapes and Ecosystems LSA, Terrestrial LSA, and Landscapes and Ecosystems RSA include: residential; recreational (e.g., hunting, all-terrain vehicle [ATV] trails, fishing, hiking, etc.); exploration; resource; industrial; transportation; rangeland; agriculture; and forestry. Forestry, agriculture, and mining in the East Kootenay region have been ongoing for well over a century, with coal being the dominant resource extracted in the area. Wildfire suppression is practiced in the Elk Valley and there have not been any large wildfires in the last several years (Tourism Fernie, 2020; British Columbia Wildfire Service, 2019). Controlled burning projects have been carried out to improve wildlife habitat and increase available forage in the Elk Valley, funded through the Fish and Wildlife Compensation Program (Fish and Wildlife Compensation Program [FWCP], 2020). Additional information on past and present land uses is provided in Chapter 1, Section 1.3.2.

The management of cumulative effects to terrestrial ecosystems, particularly old growth and mature forests and riparian habitat, is an ongoing concern in the Elk Valley due to historic, current, and ongoing mining; timber harvesting; recreation; and municipal development pressures in the area (Davidson et al., 2018; Province of B.C., 2020). Old forests are relatively rare in the Elk Valley and are impacted by multiple resource development activities and natural disturbance events, making them subject to cumulative effects (Holmes et al., 2018). Riparian areas have also been extensively impacted by anthropogenic disturbance in the Elk Valley (Davidson et al., 2018). Although EV-CEMF focuses on riparian habitat and old growth and mature forests, many of these impacts negatively affect all terrestrial ecosystems in the Elk Valley. Mitigation efforts and management responses to old growth and mature forest and riparian habitat impacts in the Elk Valley are ongoing to ensure the long-term sustainability of these ecosystems in the region.

High grazing pressure in the Elk Valley has resulted in the increase of invasive species, reduced root development, soil creep, and changes to vegetation structure that deteriorate the quality and function of alpine grasslands (Holechek et al., 2001; MacKenzie, 2004; Poole et al., 2020). Consequently, grasslands are considered at-risk in the East Kootenay region. Avalanche chutes are one of four habitat indicators for grizzly bear in the EV-CEMF. Avalanche chutes have declined only slightly for the Elk Valley as a whole and more substantially in some landscape units, primarily due to mining (Mowat et al., 2018).

The Elk River valley is located within the Upper Kootenay watershed, which supports a significant number of wetland ecosystems (FWCP and Columbia Basin Trust [CBT], 2014). These wetlands provide valuable ecosystem functions and habitat for a variety of species, including plant, bird, mammal, and amphibious species at risk, such as the western painted turtle (Chrysemys picta bellii), American badger (Taxidea taxus), and Great Blue Heron (Ardea herodias) (Walker, 2018).

In general, wetlands in the region have experienced loss and degradation due to alteration of flood regimes and habitat connectivity, loss of vegetation and stability, and decline in water quality attributed to the cumulative effects of historic and current intensive land development for agriculture, forestry, mining, water, and recreational use (FWCP and CBT, 2014). Wetlands are further impacted by invasive plant species that threaten native species abundance and diversity. Changes in temperatures and water flow in wetlands due to a changing climate can also impact affect wetland function (FWCP and CBT, 2014). While the quality and abundance of wetlands are limited by their extent, connectivity, and productivity, restoration efforts from local conservation groups and municipalities continue to preserve this ecosystem. Organizations have and continue to implement physical restoration and enhancement and action plans, such as the Upper Kootenay Enhancement Plan, which was developed to help conserve, restore, and enhance fish and wildlife by focusing on their habitats, including wetlands (FWCP and CBT, 2014; Walker and Millions, 2017; City of Fernie, 2018; Nature Conservancy Canada, n.d.; Elk River Alliance, n.d.).

13.5 Existing Conditions

In this section, information from baseline surveys and the TEM is used to describe ecosystems within and surrounding the Project footprint, Landscapes and Ecosystems LSA, Terrestrial LSA, and Landscapes and Ecosystems RSA to identify, explain, and evaluate potential Project impacts on terrestrial ecosystems.

13.5.1 Existing Regional and Local Information

Existing regional and local terrestrial ecosystems information was compiled by conducting a desktop assessment of background information in the Project study areas (i.e., the Project footprint, Landscapes and Ecosystems LSA, and Landscapes and Ecosystems RSA). Data and information sources included:

- Canadian Species at Risk Public Registry;
- British Columbia Conservation Data Centre (B.C. CDC) iMap and Species and Ecosystems Explorer;
- Scientific literature and government reports;
- Research from local non-governmental organizations (NGOs); and
- Other baseline studies for projects in the region.

To present the ecological context for the Project, the area is described using the B.C. Ecoregional Classification system and Biogeoclimatic Ecosystem Classification (BEC) system (B.C. Ministry of Forests and Range and B.C. MOE, 2010). The BEC zones present within the Landscapes and Ecosystems RSA and

Landscapes and Ecosystems LSA include Montane Spruce (MS), Interior Cedar-Hemlock (ICH), Interior Douglas-Fir (IDF), Engelmann Spruce - Subalpine Fir (ESSF) and Interior Mountain Heather - Alpine (IMA). Table 13.5-1 provides the associated labels of the 11 BEC subzones. The BEC subzones present in the Landscapes and Ecosystems LSA are described in detail in Section 13.5.2.2.1.

Table 13.5-1: Biogeoclimatic Ecosystem Classification (BEC) Present in the Landscapes and Ecosystems RSA and Landscapes and Ecosystems LSA

Biogeoclimatic Zone	Biogeoclimatic Zone Description	Percent in Landscapes and Ecosystems LSA	Percent in Landscapes and Ecosystems RSA
ESSFdk	Dry Cool Engelmann Spruce – Subalpine Fir	37%	31%
ESSFdkp	Dry Cool Engelmann Spruce – Subalpine Fir Parkland	4%	8%
ESSFdkw	Dry Cool Engelmann Spruce – Subalpine Fir Woodland	12%	16%
ESSFwm	Wet Mild Engelmann Spruce – Subalpine Fir	-	6%
ESSFwmp	Wet Mild Engelmann Spruce – Subalpine Fir Parkland	-	<1%
ESSFwmw	Wet Mild Engelmann Spruce – Subalpine Fir Woodland	-	3%
ICHmk	Moist Cool Interior Cedar – Hemlock	-	9%
IDFdm	Dry Mild Interior Douglas – Fir	-	<1%
IMAun	Undifferentiated Interior Mountain – Heather Alpine	-	6%
MSdk	Dry Cool Montane Spruce	-	5%
MSdw	Dry Warm Montane Spruce	47%	12%

13.5.1.1 Avalanche Chutes

Avalanche chutes are features that are common to mountain ecosystems that are maintained by frequent snow, rock, and ice avalanches (Quinn and Phillips, 2000). West-facing aspects along the Elk Valley north of Sparwood are subject to greater snowmelt and lesser snow accumulations and have avalanche chutes restricted to narrow gullies. Conversely, east-facing aspects in this same area often exhibit broader avalanche chute tracks. Along the Continental Divide, as well as between the Elk and Bull rivers, avalanche start zones and upper tracks are found on bare rock near peaks or ridgelines. Runout zones within the Landscapes and Ecosystems LSA rarely reach the valley floor or occur below 1,500 m asl and hence, are rare in the Dry Warm Montane Spruce (MSdw) biogeoclimatic (BGC) subzone. Snow avalanches are complex phenomena that depend on the physical attributes of the snow, terrain, and weather. Topography is a key determinant in the frequency, intensity, and timing of avalanches (Malanson and Butler, 1984; Patten and Knight 1994).

Mining activities, timber harvesting, and linear disturbance have increased substantially over the past 100 years in the Elk Valley, resulting in a decrease in the abundance of unaltered avalanche chutes (Teck, 2015; Mowat et al., 2018). Coal mining in the East Kootenay region was predominantly an underground process in the first half of the 20th century. Underground mining had minimal disturbance to avalanche chutes, as associated effects were concentrated at lower elevations (Cousins, 1981). Large-scale open-pit mining in the East Kootenay region began in the 1960s (Cousins, 1981; EV-CEMF, 2018). The Elk Valley has the largest producing coalfield in B.C. (Swain, 2007). Open-pit mining has significantly changed the abundance and distribution of avalanche systems through permanent modification and partial or complete removal of avalanche features due to resource extraction activities (Bebi et al., 2009; Kulakowski et al., 2006; Mowat et al., 2018; Quinn and Phillips, 2000).

Avalanche chutes are the result of natural disturbance cycles that promote diversity in ecosystems throughout the East Kootenay region (Quinn and Phillips, 2000). Avalanche regimes are influenced by topography, terrain roughness, vegetation structure, snowpack, and weather (Kulakowski et al., 2006; Malanson and Butler, 1984). Plant diversity is highest in active avalanche tracks, and management that alters the frequency of avalanching can lead to changes in plant and habitat diversity (Rixen et al., 2007). Frequency, intensity, and timing of avalanches are key determinants of the ecological effect they will have (Patten and Knight, 1994; Quinn and Phillips, 2000).

Avalanche regimes directly impact how successional plant communities will develop (Patten and Knight, 1994) and are the dominant source of disturbance shaping vegetation structure (Bebi et al., 2009). Large avalanches can reset forest succession by maintaining shrub and herb vegetation and contributing to species and structural diversity (Bebi et al., 2009; Kulakowski et al., 2006). Smaller, slower avalanches have a lesser effect on vegetation and allow tree survival, creating a transitional zone to a more established forest structure (Bebi et al., 2009). Changes to local site characteristics by anthropogenic disturbance have implications on the severity and frequency of avalanches. In the Elk Valley, impacts to avalanche chutes are commonly due to mining, forestry, linear disturbance, and recreation. Industrial disturbance and human triggered avalanches may lead to more frequent, smaller avalanches rather than larger avalanches that would be naturally triggered.

Mining operations at high elevations and in avalanche terrain can necessitate avalanche risk mitigation, utilizing explosive control and passive or active mitigation measures (Campbell et al., 2007; Jamieson and Stethem, 2002; Kulakowski et al., 2006). Historically, clear-cutting practice was the standard, and large-scale logging may have contributed to broadening avalanche tracks by lowering the resistance to mass snow movements (Anderson, 2005; Beaudry et al., 2010; Quinn and Phillips, 2000; Weir, 2002).

Linear disturbance including the development of roads, trails, and smaller rail lines increased in the early 1900s as industrial development grew quickly in the Elk Valley. Linear disturbances were limited to lower elevations until the 1950s and likely affected very few if any avalanche runout zones in the Elk Valley (Teck, 2015). Road development through avalanche ecosystems has not removed avalanche features entirely, but can reduce habitat quality for wildlife species including bighorn sheep, wolverine, and grizzly bear by increasing disturbance and human access (i.e., displacement and mortality risk; Mowat et al., 2018). Road impacts to avalanche chute vegetation can include dust input and the introduction of non-native species to avalanche chutes.

In the Elk Valley, active avalanche control measures are applied in access corridors where they transect major avalanche features. Avalanche control includes areas near Morrisey on avalanche paths affecting Highway 3, and along logging roads such as in Harvey Pass while active logging occurs in the Flathead Valley (J. Volp, personal communication, January 6, 2021). Fernie Alpine Resort has an extensive avalanche control program due to the presence of avalanche terrain and has modified the disturbance regime within the resort footprint. Road, lift, trail construction, and brushing activities within avalanche tracks at the resort have modified their habitat value.

Bare ground and disturbances from frequent avalanches create an environment favourable for the establishment of agronomic grasses and invasive weeds, which can have impact on early seral communities (Burlington Northern Santa Fe Railway, 2006). Successional ecological communities following avalanche disturbances can be influenced by the introduction of non-native and invasive species. Invasive species are a threat to native plant species diversity and can cause rapid and lasting change on the landscape due to a lack of natural predators and competitive traits (Invasive Species Council of British Columbia [ISCBC], 2017). The intensification of industry and development, and movement to higher elevation sites since the 1950s, has likely increased the mobility and likelihood of establishment of non-native and potentially invasive species in avalanche chutes within the Landscapes and Ecosystems RSA. At present, non-native species are not widespread within the Elk Valley at elevations where the bulk of avalanche chutes are found.

13.5.1.1.1 Transboundary Considerations

Suitable terrain for the development of avalanche conditions may occur throughout the Rocky Mountains, extending into Alberta to the east, and into the United States of America (U.S.A) to the south. Although specific mapping of avalanche chute ecosystems in these jurisdictions is not available, it is reasonable that such ecosystems are likely to occur in these areas and, where potential means exist, have potential to be affected by the Project.

13.5.1.2 Grasslands

Occupying less than 1% of B.C.'s land base, grasslands are a product of temperature, precipitation, and physical factors that cause an environment unsuitable for tree growth (Wikeem and Wikeem, 2004). Within the East Kootenay region, grasslands occupy 2% (46,415 ha) of the area (Wikeem and Wikeem, 2004). Contrary to elsewhere in the province, grassland ecosystems in the Elk Valley are found most commonly at high elevations within the ESSF BGC units of the upper Elk Valley (Wikeem and Wikeem, 2004). Apart from these high elevation grasslands within the Elk Valley, grasslands are often discontinuous and occupy specialized habitats such as river breaks, gravelly terraces, or steep and south slopes within extensive forest ecosystems (Wikeem and Wikeem, 2004). Alpine grasslands occur in the ESSF at higher elevations and have characteristic cold winters, growing season frosts, and intermittent or low snow cover (MacKillop et al., 2018). The abundance of brushlands and grasslands in the Elk Valley has been reduced over the last century due to a variety of disturbances, including the alteration of the natural fire regime, coal and other mining, timber harvesting, and settlement, particularly at low and mid-elevations (Wikeem and Wikeem, 2004; MacKillop et al., 2018). It is estimated that a total of 508 ha or 9% of grasslands in the Landscapes and Ecosystems RSA has been lost or modified between 1950 and 2014 (Golder Associates [Golder], 2015), as outlined in Table 13.5-2.

Table 13.5-2: Historical Grassland Impacts in the Landscapes and Ecosystems RSA

Stressor	Loss or Modification of Grasslands in the RSA (ha)	Loss or Modification of Grasslands in the RSA (%)
Mining	100	2
Timber Harvesting	209	4
Settlement	155	3
Anthropogenic Features	44	<1
Total	508	9

Fire has always been an important disturbance factor to terrestrial ecosystems. Burning by Indigenous peoples was prominent in the history of grassland and savannah ecosystems in North America (Daubenmire, 1968). Grasslands at low elevations are historically fire-maintained ecosystems with frequent low-intensity disturbances (MacKillop et al., 2018; Keim et al., 2014). Grassland ecosystems benefit from wildfires as they remove litter, reduce biological soil crusts, and release nutrients (MacKillop et al., 2018). The last large fire event in the Elk Valley occurred in the 1930s, which created open grazing range and lands and led to the proliferation of wildlife populations and increased ranching viability (Casselman, 1998; McCauley, 2000). Fire exclusion because of fire suppression activities has reduced both the patch size and abundance of grasslands in the Elk Valley (Demarchi et al., 2000; Mountain Goat Management Team [MGMT], 2010; Poole and Ayotte, 2019). As a result, trees and shrubs have encroached into grasslands, shifting vegetation from grasslands to forested communities. Longer fire return intervals in the region have resulted in considerable changes in vegetation composition occurring in all BEC zones that support grasslands and savannahs (Gayton et al., 1995). Fire suppression practices have resulted in a greater abundance of young forests, reducing the abundance of unforested structural stages (Kirby and Campbell, 1999).

Large-scale open-pit mining in the Elk Valley has resulted in the loss of a substantial area of grasslands by physical removal, invasive plant spread, and overgrazing (Golder, 2015; Poole and Stuart-Smith, 2006; Poole et al., 2020; Poole and Ayotte, 2019). It is estimated that 100 ha or 2% of grasslands in the Landscapes and Ecosystems RSA has been lost as a direct result of coal mining between 1950 and 2014, as illustrated in Table 13.5-2. Direct effects of logging contributed to opening large areas of successional grassland and shrub-steppe vegetation throughout the East Kootenay region and southern Rocky Mountain Trench (Casselman, 1998). Coniferous cutblocks can produce many times the amount of forage originally produced by the mature coniferous forest, which provides valuable grazing opportunities for domestic livestock and wildlife (Sundquist, 1995). It is estimated that 209 ha of grasslands have been modified due to timber harvesting.

Settlement in the East Kootenay region and Elk Valley throughout the 1900s was concentrated in valley bottoms containing high-value low elevation grasslands. Settlements led to significant increases in anthropogenic disturbances, including transportation corridors, utility corridors, artificial waterbodies, residential footprints, and agricultural areas. Native vegetation was modified, and non-forested ecosystems were adapted for agriculture and ranching developments, resulting in new grassland areas for grazing and cropping (Regional District of East Kootenay [RDEK], 2020; Szkorupa and Mowat, 2010). It is estimated that 155 ha or 4% of grasslands in the Landscapes and Ecosystems RSA have been permanently modified due to settlement activities, and 44 ha or <1% of grasslands have been permanently modified due to linear and other industrial disturbances between 1950 and 2014 (Golder, 2015) as outlined in Table 13.5-2.

The widespread presence of high elevation grasslands in the Landscapes and Ecosystems RSA is unique for the province, and these ecosystems can be characterized as possessing high diversity of at-risk plant species (MacKillop et al., 2018). Native grasslands in the Landscapes and Ecosystems RSA are generally vegetated by bunchgrasses such as Idaho fescue (Festuca idahoensis) and rough fescue (Festuca campestris); pinegrass (Calamagrostis rubescens); diverse forbs such as arnica (Arnica spp.), penstemons (Penstemon spp.), and buckwheat (Eriogonum spp.), low shrubs such as kinnikinnick (Arctostaphylos uva-ursi), juniper (Juniperus communis), and grouseberry (Vaccinium scoparium); and diverse mosses (MacKillop et al., 2018). High elevation grasslands in the Elk Dry Cool Engelmann Spruce – Subalpine Fir

(ESSFdk1) and the Dry Cool Woodland Engelmann Spruce – Subalpine Fir (ESSFdkw) are associated with a high diversity of at-risk plant species. Within the Landscapes and Ecosystems RSA, several high elevation grassland ecological communities are listed as Endangered under the Species at Risk Act (SARA), such as the Idaho fescue-sulphur buckwheat (Eriogonum umbellatum)-sandwort and Rough fescue-sulphur buckwheat-sandwort grasslands (Poole and Ayotte, 2019).

Early reclamation practices on industrial disturbance in B.C., such as coal mining, emphasized planting of agronomic grasses and legumes to stabilize soils and rapidly establish plant cover to compensate for adverse effects on wildlife (Lancaster et al., 2018; Lowenberger, 1973). As a result, reclaimed mining areas in the Landscapes and Ecosystems RSA are primarily composed of agronomic grass species, rather than by the native species that occurred historically (Keim et al., 2014). Despite these reclamation efforts, many grasslands sites previously vegetated by native species and valuable wildlife habitat are now considered degraded habitat (jeffersonii Badger Recovery Team, 2008; Keim et al., 2014). Linear disturbance directly impacts grassland ecosystems by disturbing soils and vegetation to construct roads, powerlines, and pipelines, leading to increased industrial and recreational traffic within remote areas. Linear disturbances exponentially increase the spread of non-native and invasive species, particularly in grassland ecosystems (ISCBC, 2017; Poole et al., 2020).

Farmed areas are now permanent, modified non-forested grassland ecosystems. Crop depredation by elk (Cervus canadensis) and deer (Odocoileus virginianus; Odocolieus hemionus) is a long-term concern, impacting ranchers and farmers as well as wildlife populations (VAST Resource Solutions Inc., 2014). The dominant crop types in the Elk Valley are forage pasture, oats (Avena fatua), and Christmas trees (VAST Resource Solutions Inc., 2014).

Disturbance activities introduce and spread invasive and alien plant species, which reduce crop yield, degrade native plant and animal habitat, reduce property value, spoil aesthetics, and can be harmful to humans, livestock, and wildlife (ISCBC, 2019). Some common invasive species in the East Kootenay region include non-native hawkweeds (Hieracium spp.), knapweeds (Centaurea spp), sulphur cinquefoil (Potentilla recta), non-native annual bromes (Bromus spp.), and common St. John's-wort (Hypericum perforatum). Agronomic introduced grasses such as Kentucky bluegrass (Poa pratensis) and Canada bluegrass (Poa compressa) may also invade grasslands, especially on level sites and moister grasslands (MacKillop et al., 2018).

13.5.1.2.1 Transboundary Considerations

In Alberta, mid-elevation grasslands occur in the Montane subregion at an elevation range of 825 m to 1,850 m asl, and high elevation grasslands occur in the Subalpine subregion at an elevation range of 1,300 m to 2,300 m asl (Downing and Pettapiece, 2006). Grasslands in Alberta have a similar composition to the Elk Valley, commonly dominated by bunch grasses, pine grasses, diverse forbs, and low shrubs. Grasslands in immediately adjoining portions of Alberta occur more frequently than in the adjacent Elk Valley (Baker et al., 2020; Willoughby and Alexander, 2007). High elevation grasslands extend into Montana, generally occurring as two plant community types: a rough fescue-Idaho fescue association and the Idaho fescue-bluebunch wheatgrass (Pseudoroegneria spicata) association, which have analogues in B.C. (Vance et al., 2017). While the loss of grasslands is important regionally, loss of grasslands as a result of the Project is limited to the Project footprint and as such, the Project is not expected to result in transboundary effects to grasslands in Alberta or the U.S.A.

13.5.1.3 Riparian Habitat

In the Landscapes and Ecosystems RSA, riparian areas occur at lower elevations on floodplains and along streams and wetlands. Mapped streams do not always contain enough moisture to be considered riparian (Province of B.C., n.d.). Riparian areas are common along the Elk River and Fording River, and otherwise occur in relatively narrow bands in other areas of higher relief due to steep banks or very coarse streambank soils (KES, 2020b).

The vegetation composition of riparian areas varies widely with elevation, geomorphology, parent materials, soils, and characteristics of the waterbody. Healthy riparian zones contain native plant species with extensive root systems that stabilize banks, relying on floods to recharge aquifers for drier periods (Amlin and Rood, 2003). Adjacent to larger bodies of water and in areas with more severe flooding events, large trees and shrubs are usually present (Alberta Riparian Habitat Management Society [ARHMS], 2020). Adjacent to temporary streams, riparian areas are generally dominated by lower stature plants such as sedge species (ARHMS, 2020). Alteration of water levels can change the structure and composition of riparian areas (Neumayer et al., 2020). Riparian areas along large river systems such as the Elk River contain willow and cottonwood (Populus spp.) communities that rely on flooding for reproduction (Amlin and Rood, 2003). Cottonwoods rely on a continual supply of water and may be replaced by shrubs, rushes, or sedges (Carex spp.) when water availability is reduced (Amlin and Rood, 2003).

Riparian areas are susceptible to invasive and agronomic species because of the frequency of disturbance and many opportunities for seeds, rhizomes, and roots to be carried downstream and establish on exposed soil (New York Department of Environmental Conservation [NYDEC], 2017). Reclamation practices on industrial disturbances in B.C., including the reclamation of coal mining, historically emphasized planting of agronomic grasses and legumes (Lancaster et al., 2018; Lowenberger, 1973). The high level of moisture and frequency of bare ground can allow invasive species to quickly establish and alter the composition of a previously native riparian area (NYDEC, 2017).

13.5.1.3.1 Transboundary Considerations

The Continental Divide separates watersheds between Alberta and B.C., with flow into the Atlantic and Pacific oceans, respectively. Several passes between Alberta and B.C. contain riparian habitats that cross the Continental Divide. In Alberta, riparian areas occur throughout all subregions and are concentrated in valley bottoms and floodplains, with large aspen more prevalent in abundance and distribution (Downing and Pettapiece, 2006). South of the Elk Valley in Montana, the Continental Divide continues with riparian areas present throughout all sub-regions. The Elk River outlet into the Canadian portion of Lake Koocanusa is located approximately 80 km southwest of the Project. Lake Koocanusa extends 65 km from the U.S.A border to the Kootenay River Inlet, providing large riparian areas upstream and non-natural riparian areas surrounding the reservoir. Water levels in the lake are controlled by Libby Dam, which results in significant seasonal variations in riparian habitat (Wetland Stewardship Partnership [WSP], 2010). Given the presence of riparian habitats in areas downstream and/or downwind from the Project, there is potential for the Project to result in transboundary effects to riparian habitats in the U.S.A. and/or the Province of Alberta.

13.5.1.4 Old Growth and Mature Forest

The amount of old growth forest and mature forest in the Elk Valley is well below historic amounts, and what exists is highly fragmented in small patches, particularly at lower elevations (Holmes et al., 2018).

Old forests are defined as forests older than 140 years, while mature forests are 100 to 140 years old for the MSdw and 120 to140 years in the ESSFdk1 and ESSFdkw (Holmes et al., 2018). In the Elk Valley, old growth and mature forest occurs in all forested BGC zones (MS, ESSF, ICH). Forest abundance and distribution throughout the Landscapes and Ecosystems RSA have been influenced by a history of wildfire, wildfire suppression, disease, logging, mining, and European settlement (Holmes et al., 2018). Within the Landscapes and Ecosystems LSA, evidence of historic wildfires, mining exploration, and past logging is widespread.

Stand initiating disturbances are processes that dramatically alter the existing forest structure and initiate secondary succession, producing a new forest stand (Province of B.C., 1995). In the Elk Valley, large disturbances include fire, insect outbreak, and logging (Holmes et al., 2018). Old growth and mature forests in the Elk Valley were heavily impacted by large and severe wildfires in 1919 and the 1930s, resetting succession in more than 100,000 ha of old forest (Holmes et al., 2018). More frequent wildfires will consume CWD mass in old growth stands (Feller, 2003). Following a wildfire, there is a rapid increase in CWD due to fire-imposed tree mortality (Spies et al., 1988) that creates downed CWD and snags. Based on compiled wildfire history, 45% or 5,881 ha of the Landscapes and Ecosystems LSA has experienced wildfire of varying severity over the past 100 years (British Columbia Wildfire Service, 2019). The extent of wildfire suppression since the 1940s has led to the build-up of fuels, making stands more prone to severe, stand-initiating wildfire events (Daniels et al., 2005).

Mountain pine beetle (Dendroctonus ponderosae) is present in the Elk Valley (Cullingham et al., 2011; Goyette et al., 2019), although it is not currently at endemic levels (Todd Blewett, personal communication, February 2, 2021). In pure lodgepole pine (Pinus controrta) stands, mountain pine beetle kill can result in a stand initiating disturbance. In mixed species stands, mountain pine beetle can result in changes in the structure of stands that can still be considered mature or old. An estimated 250,000 metres cubed (m^3) of pine has been lost to mountain pine beetle in the Cranbrook TSA within which the Landscapes and Ecosystems RSA is located (FLNRORD, 2014b). As of 2021, the most severe insect infestation of old growth and mature forests is spruce beetle (Dendroctonus rufipennis), which is attacking mature and old Engelmann spruce (Picea engelmanii) in the upper Elk Valley (Todd Blewett, personal communication, February 2, 2021). Beetle killed trees contribute to standing dead snags (Chan-McLeod, 2006). Coarse woody debris is created when snags fall (Lewis and Hartley, 2005). Downed wood does not satisfy all habitat requirements until it has softened, and decomposition to this stage in some stands occurs after 40 to50 years (Chan-McLeod, 2006; Hawkes et al., 2004). High amounts of standing dead snags and CWD following severe beetle infection makes stands more prone to high intensity wildfires (Chan-McLeod, 2006; Feller, 2005; Hawkes et al., 2004).

Timber harvesting in the Elk Valley, beginning in the early 1900s, targeted older forests with higher economic value, until the early 1980s when old growth protection management strategies were implemented across the province (Holmes et al., 2018). Logging has reduced the abundance of old growth and mature forests at lower elevations in the MS and ICH within the Elk Valley (Holmes et al., 2018). Old growth and mature forest spans 51,944 ha (40% of all old growth and mature forest in the Landscapes and Ecosystems RSA) on Crown forest land or under timber agreement, and 16,128 ha (12% of all old growth and mature forest in the Landscapes and Ecosystems RSA) of private managed forest. Low mechanization in the early days of logging only removed high-quality merchantable timber from stands, leaving considerable amounts of CWD and low-quality timber on site (Arsenault, 2002). Current harvesting practice has shifted towards ecosystem management, and CWD is recognized as an important component of the forest that requires retention (Arsenault, 2002). Old growth and mature forest has been recognized as having distinct ecosystem value, with retention targets outlined in the B.C. Forest Practices Code (BC FPC; Province of B.C., 1995). Forest harvesting has led to a fragmented landscape that does not resemble the natural pattern of old growth and mature forest distribution (Province of B.C., 1995). The Biodiversity Guidebook (Province of B.C., 1995) presents targets for patch size distribution, which were evaluated by EV-CEMF (EV-CEMF, 2018). Increased disturbance in the Elk Valley over the last century has increased the abundance of small (1 to 5) ha patches of old growth and mature forest, while reducing the number of large patches (Holmes et al., 2018).

Settlement and mining have impacted the amount of old growth and mature forest in the Elk Valley. Clearing for development and agriculture in the MS and ICH has reduced old forest since the 1900s, particularly in areas of the Elk Valley near railway lines (EV-CEMF, 2018; Holmes et al., 2018). As no regulations govern the retention of mature or old forest on private lands, these lands may be at risk of logging for agricultural, residential, or timber usage (Holmes et al., 2018). The amount of old growth and mature forest under mineral tenure is significant, as future exploration and mining could remove significant areas of forest, lasting multiple decades (EV-CEMF, 2018). Disturbances that remove old growth and mature forest impact connectivity, which is important for wildlife habitat use.

Forest composition and structure refer to the tree species in a stand and their physical arrangement within the stand, including seral stage, canopy layering, size class distribution, habitat edge, and canopy closure. Small-scale disturbances in old growth and mature forests due to factors such as windthrow and endemic insect or disease caused mortality are generally followed by the re-establishment of vegetation and new tree growth. This results in a mosaic of regeneration phases and varied canopy closure (Rapp, 2003). Seral stage is a key attribute that provides information on features such as canopy structure and stand density (Kimmins, 2009; United States Department of Agriculture Forest Service [USDA FS], 2004). As a forest stand matures, tree mortality takes place, resulting in increasing canopy gaps with age (Holmes et al., 2018). Forest edges create abrupt changes in stand microclimate, resulting in negative effects on old growth and mature forest habitat value up to 250 m from the edge (Holmes et al., 2018; Kremsater and Bunnell, 1999; Ross and Tóth, 2016). Changes in microclimatic factors create significant changes in air temperature, soil temperature, wind speed, humidity, and soil moisture (British Columbia Ministry of Forests, 1998; Chen et al., 1993). Edge effects have been produced by human activities including logging, mining, development of linear features, and non-Indigenous settlement (Holmes et al., 2018). Edge effects resulting from human activities and natural disturbances in old growth and mature forests can have a variety of impacts on forest structure, depending on the size and type, and subsequent impacts on light intensity, humidity, and soils (Chen et al., 1993).

Mixed-severity wildfires in the East Kootenay region have historically created diversity in forest stand age and canopy closure (Daniels et al., 2005; Daniels et al., 2011). Severe stand-initiating wildfires that occurred in the 1920s and 1930s reset over 100,000 ha of old forest to early seral conditions (Holmes et al., 2018). Historic wildfire events, insect outbreak, and disease, along with timber harvesting, create forest edges that regrow over time. Edges that can regrow over time are called transitional edges (Holmes et al., 2018). Permanent edges do not allow vegetative regrowth and result in habitat loss (Holmes et al., 2018). Since the mid-1900s, wildfire suppression activities have increased canopy and tree density, resulting in even aged forests with built-up ground fuel (Daniels et al., 2005). Even aged forests are more susceptible to severe stand-initiating wildfires and insect outbreak (Daniels et al., 2005; Kimmins, 1995). Disturbances resulting from disease or insect outbreak can create significant transitional edges due to widespread tree death within a forest, making stands more prone to severe wildfires (Chan-McLeod, 2006; Feller, 2005; Hawkes et al., 2004). Disease causes selective mortality, creating canopy gaps and increasing diversity in seral stage (Castello et al., 1995). Wildfire suppression activities have allowed timber harvesting to emerge as the primary disturbance creating variation in forest age that returns old growth forests to early seral stages (EV-CEMF, 2018; Kimmins, 1995; USDA FS, 2004). High rates of harvesting disturb old forests at rates that are higher than historic natural disturbances (Kimmins, 1995).

Linear features such as roads, powerlines, and pipelines increased by 1,529 km between 1950 and 2015 in the Landscapes and Ecosystems RSA, amounting to approximately 0.8% of the total area (EV-CEMF, 2018). Land clearing for the construction of linear features, settlement, agriculture, and for industry produces permanent edges with open areas where forest regeneration is suppressed (EV-CEMF, 2018; Holmes et al., 2018; Jansson, 2009). Permanent edges that have no canopy cover can have long lasting effects on the landscape, as they divide large intact patches of forest and contribute to fragmentation (Jansson, 2009). Linear features, such as roads, create unique edge effects due to increased vehicle traffic, which can further degrade habitat quality (Holmes et al., 2018).

13.5.1.4.1 Transboundary Considerations

Timoney (2001) identified eleven different generalized types of old growth forest with potential to occur in the Rocky Mountain Natural Subregion, including: plains cottonwood (Populus deltoides), aspen (Populus tremuloides) grove, aspen forest, balsam poplar (Populus balsamifera), Douglas fir (Pseudotsuga menziesii), limber pine (Pinus flexilis), montane parkland, lodgepole pine, and Engelmann spruce – subalpine fir (Abies lasiocarpa). In Alberta, old growth forests are affected by wetland drainage or alteration of flooding regimes, alteration of fire frequency and severity, resource development and disease (e.g., white pine blister rust [Cronartium rubicola]) (Timoney, 2001). There are no known publicly accessible inventories or other form of documentation of old growth and mature forest in the vicinity of the Project in Alberta.

13.5.1.5 Wetland Ecosystems

Existing regional and local information on wetland ecosystems in the Elk Valley is limited, with the exception of the regional provincial field guide to ecosystems of East Kootenay (MacKillop et al., 2018) and consultation with provincial and regional wetland experts.

The major BGC units near the Project are the Dry Warm Montane Spruce (MSdw), Elk Dry Cool Engelmann Spruce-Subalpine Fir (ESSFdk1) variant, Dry Cool Woodland Engelmann Spruce-Subalpine Fir (ESSFdkw), and Dry Cool Parkland Engelmann Spruce-Subalpine Fir (ESSFdkp), which are found throughout East Kootenay; however, their relative contribution varies between areas with several other BGC subzones and variants being found in the East Kootenay. Wetland diversity is high in the MSdw and includes bogs, fens, swamps, marshes, and shallow waters (MacKillop et al., 2018). Wetland and flood ecosystems are abundant and extensive along the major river valleys of the East Kootenay, including the Columbia, Kootenay, and Elk Rivers. Beyond these valley bottom floodplains, wetlands are small and uncommon, but provide important landscape variability that influences biodiversity and stability. In the ESSFdk1, above and adjacent to the MSdw, fens are the most common wetlands (MacKillop et al., 2018). Marshes and swamps are also present, and alpine wetlands occur at the highest and coldest elevations. Wetlands may occur in the shallows of small lakes and along seepage areas of this unit.

The highest elevation of the Terrestrial LSA falls within the ESSFdkp, a BGC unit characterized by stunted trees and open areas of grassland, meadows, heath, and avalanche paths. Alpine wetlands are restricted to seepages on slopes and saturated areas in flat areas and depressions. Alpine wetlands are usually forb-dominated but may be graminoid dominated, typically with black alpine sedge (Carex nigricans; MacKillop et al., 2018).

Fire and mountain pine beetle have and continue to influence landscape-level structure and tree species composition in the MSdw, which influences wetlands in the forest matrix. Fire intensity may be less along watercourses, so bands of forest along the watercourses are sometimes spared. Wetlands in these bands may represent important ecological legacies for both the ecological community they represent and the organisms which form those communities. Evidence of historical bush mills and mining along Alexander Creek shows past disturbances that influenced ecological communities, including wetlands. These bush mills are scattered throughout the unsettled areas of the East Kootenay (MacKillop et al., 2018). Urban development and mining have altered the landscape and the ecology of the area. Wetlands are susceptible to direct effects such as excavating, draining, and clearing, and indirect effects related to forest cover removal, erosion, and the input of sediment, nutrients, and chemicals carried by water or wind. Ungulates, including cattle and elk, can alter wetland and transitional wetland ecosystems and alter riparian vegetation that filters and protects isolated and connected wetlands through tramping and soil and vegetation disturbance.

The severity and frequency of fires are less predictable in the ESSFdk1 than in the MSdw (MacKillop et al., 2018), but can have considerable effects on forest cover and, therefore, on wetlands within the forests. Mining has affected forest cover and landform in the ESSFdk1, and consequently wetlands, although no information on the number and type of wetlands affected, destroyed, or created, is readily available. Field observations suggest recent human disturbance is limited in the ESSFdk1 of the Terrestrial LSA; however, recreational activity such as off-road vehicles in natural areas, some with posted seasonal restrictions on access, may exacerbate adverse ecological effects such as the spread of non-native, invasive plant species, disturbance of wildlife, and the degradation of ecological communities.

Wetlands are susceptible to disturbances from alteration to watercourses such as diversions, siltation, and pollution (Cox and Cullington, 2009). Draining, diking and conversion of wetlands occurred throughout the Elk Valley for urban development (Cox and Cullington, 2009). To the west of the Project, the Blue-listed balsam poplar, (black cottonwood) – spruces/red-osier dogwood mid bench flood ecosystem was identified during baseline field surveys in the vicinity of Teck's Elkview Operations (Teck, 2015).

13.5.1.5.1 Transboundary Considerations

The Elk River outlet into the Canadian portion of Lake Koocanusa is located approximately 80 km southwest of the Project. Lake Koocanusa extends 65 km from the U.S.A. border to the Kootenay River Inlet, providing a wide range of aquatic habitat. Wetlands are not present along the foreshore of Lake Koocanusa (Leschied, 2017). 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.

13.5.2 Baseline Programs

13.5.2.1 Methods

13.5.2.1.1 Terrestrial Ecosystem Surveys and Mapping

Terrestrial Ecosystem Mapping (TEM) stratifies a landscape into map polygons based on ecological features including climate, vegetation, physiography, surficial material, bedrock geology, and soil (Province of B.C., 1998). TEM is based on the Biogeoclimatic Ecosystem Classification (BEC) system, which was developed in B.C. to classify and manage sites based on ecosystem features. TEM involves more detailed information than PEM, as it requires direct air-photo interpretation and field surveys of ecosystem attributes to verify ecosystem identification and boundaries (Province of B.C., 1998). The map products offer valuable information for various uses, such as forest management, wildlife capability and suitability mapping, and potential rare species mapping (Province of B.C., 1998). Provincial Vegetation Resource Inventory (VRI) data were utilized to aid in determining structural stage in the Project TEM and for further refining the old growth and mature forest mapping within the Landscapes and Ecosystems LSA. Additional details of the approach to TEM are provided in Appendix 13-A.

The objective of the Project-specific TEM was to create a survey intensity level three, 1:20,000 scale TEM (Province of B.C., 1998) to be surveyed at a survey-intensity level four, for the Landscapes and Ecosystems LSA. TEM was utilized to map and characterize ecosystems within the Landscapes and Ecosystems LSA. TEM field sampling was conducted in 2014, 2018, and 2019 and included the completion of 217 field plots (97 ground plots and 120 visual plots). Field sampling targeted one inspection per 100 ha at a ratio of 1:3 ground to visual plots.

A sampling plan was developed to ensure representative sampling of all BGC units found in the Landscapes and Ecosystems LSA. During this process, a new BEC for the southern East Kootenay was being drafted by the province; thus, sampling was initially conducted using an interim classification (D. MacKillop, personal communication, 2014). The final sampling and classification were completed using the final published version (MacKillop et al., 2018). TEM was utilized to map and characterize ecosystems within the Landscapes and Ecosystems LSA.

The TEM study used a combination of aerial photograph interpretation, visual inspection, and ground inspection surveys to determine the location, extent, and classification of terrestrial ecosystems in the Landscapes and Ecosystems LSA (Appendix 13-A). The level of investigation dictated the level of classification. Information collected as part of the TEM field sampling and data entry included site factors such as elevation, slope and aspect, floristic survey, BEC site series with modifiers, soil classification, seral and structural stage classification, and other relevant fields used to characterize ecosystems. Visual inspections only captured key features necessary for site series/map code determination.

Ecosystem attribution followed provincial standards (i.e., Resource Inventory Committee Standard for Terrestrial Ecosystem Mapping [Province of B.C., 1998]) and included structural stage and site modifiers. For non-forested ecosystems, more generalized site classes were mapped (e.g., Brushland [Gb]) where detailed ground observations do not exist; while site associations (e.g., Choke cherry – Snowberry – Bluebunch wheatgrass [Gb04]) were mapped where detailed observations recorded species composition, including for grassland (Gg), wetland swamps (Ws), brushlands (Gb), krummholz (Sk), and herb and shrub avalanche tracks (Vh and Vs). All descriptions, excluding non-vegetated, sparsely vegetated, and anthropogenic groups, were obtained from MacKillop et al. (2018). Descriptions for non-forested ecosystems were obtained from MacKenzie (2012).

Surveys of vascular plants, ecological communities of management concern, and sensitive ecosystems were carried out during the TEM field surveys. The presence of invasive species was also noted for inclusion in other reports related to these features. Following the publication of the new East Kootenay BEC (MacKillop et al., 2018), BGC mapping changes were examined and refined classification of non-forested ecosystem were attributed, where possible. Additional sampling was completed in 2019 to improve the classification of avalanche tracks and wetlands to aid in the assessment of wildlife habitat.

Observations of ecosystem composition were recorded during other baseline surveys, such as listed plants and sensitive ecological community mapping (Appendix 14-B). The baseline survey effort for the landscapes and ecosystems assessment is provided in Table 13.5-3. Additional samples were used to further "ground-truth" the TEM but do not appear in Table 13.5-3.

Table 13.5-3: Baseline Survey Effort for the Landscapes and Ecosystems Assessment

Survey Type	Survey Year	Study Area	Survey Standards	Sample Effort	Data Collected
TEM	2014, 2018, and 2019	12,886 ha	Sample intensity suitable for: wildlife capability assessment, local resource planning, habitat enhancement prescriptions	Intensity level 3[1]	217 plots
Wetland Ecosystem	2017, 2018, and 2019	24,221 ha	Sample intensity suitable for: characterizing species composition, structure, shape classification, and detailed delineation of 36 wetlands	Not Specified	Detailed documentation of 36 wetlands in the Terrestrial LSA
Invasive Plants	2014	12,886 ha	Vehicle traverse: Provincial Invasive Alien Plant Program (IAPP) distribution and density class codes assigned to each occurrence (Government of B.C., n.d.)	Visual inspection	191 individual occurrences of 16 species

Note:
1. Intensity Level 3 denotes a sample was measured for each 30-59 ha, of study areas at a map scale of 1:20,000 (Province of B.C., 1998).

The occurrence of invasive plant species within the Landscapes and Ecosystems LSA was informed by the invasive plant species baseline surveys conducted to evaluate the presence of invasive plants in disturbed areas, including roads and drill pads (Appendix 13-C). Invasive species occurrence was also noted as part of the TEM and listed plant survey plots in terrestrial ecosystems. The invasive plant surveys quantified weed abundance in a different manner to TEM and listed plant ground plots. Density was assessed based on number of plants/m^2 for the former and on a percent cover basis over a plot of approximately 400 m^2.

Avalanche Chutes

Project TEM (Appendix 13-A) was utilized to map and characterize avalanche chute ecosystems within the Landscapes and Ecosystems LSA, whereas the Cranbrook TSA PEM was used to map avalanche chute ecosystems in the Landscapes and Ecosystems RSA. The classification of avalanche tracks follows MacKillop (2018). KES modified the classification of avalanche chute ecosystems to aid in wildlife habitat assessment. With limited safe access to steep avalanche chutes, it was not possible to identify site-specific vegetation communities, and therefore the Project TEM did not classify avalanche chute ecosystems to the site association level, presenting a data gap in the review of existing conditions. The data gap was addressed by using Project TEM map units to define avalanche chute ecosystems and include herbaceous meadows (i.e., Vhd, Vhm, Vh01), shrub thickets (i.e., Vs, Vs10), and treed runout zones (i.e., Vt).

Grasslands

Grassland ecosystems within the Landscapes and Ecosystems LSA were mapped as a component of the Project TEM (Appendix 13-A). Ground observations gathered during sampling for the TEM and listed plant surveys were used to map and characterize grassland ecosystems found within the Landscapes and Ecosystems LSA. For the TEM, ecosystems identified as grasslands collectively include typic grasslands (i.e., graminoid-dominated sites with shrub species comprising <10% of land cover), brushlands (i.e., grassland ecosystems with shrub species comprising >10% of land cover composition and varying amounts of graminoid species), and alkaline/saline meadows (i.e., graminoid or halophyte-dominated sites in shallow, salt-accumulated basins), as described in Mackenzie (2012). Where observed on the ground by Project TEM personnel, grassland ecosystems were assigned specific site class codes based on the plant community species composition (e.g., Choke cherry – Snowberry – Bluebunch wheatgrass [Gb04]), based on the classification system provided in MacKillop et al. (2018). Where grassland ecosystems were not observed by the Project TEM personnel, these areas were assigned more generalized site class codes (e.g., Brushland [Gb]).

The mapping of grasslands within the Landscapes and Ecosystems RSA relied on the Cranbrook TSA PEM (FLNRORD, 2014c).

Riparian Areas

Riparian areas within the Landscapes and Ecosystems LSA were mapped using the Project TEM (Appendix 13-A). Riparian habitats include those Project TEM polygons characterized by site series of elevated soil moisture regime (e.g., site series 110, 111, non-forested floodplain site series) typically attributed to the transition zone adjacent to waterbodies, but not including the waterbodies themselves.

As TEM mapping was limited to the Landscapes and Ecosystems LSA, mapping for the Landscapes and Ecosystems RSA used the riparian areas mapping prepared by the EV-CEMF (Davidson et al., 2018). The Project TEM was developed by manual delineation and attribution of ecosystem polygons by subjective interpretation of abiotic (e.g., terrain, soil) and biotic (e.g., vegetation) conditions, whereas the EV-CEMF (Davidson et al., 2018) riparian areas were delineated from hydrological modelling using regional precipitation and LiDAR data (Fernandez et al. 2012). Given the difference in methodology and scale between the Project TEM and EV-CEMF (Davidson et al., 2018) riparian mapping, there is potential for variation in the mapped location and area of riparian habitat in the Project footprint and respective study areas. Site series attributed to riparian habitats included: Flood Association - Fringe (Ff); Low Bench Flood (Fl; including associated defined vegetation community variants), Middle Bench Flood (Fm02), and forested site series 110 and 111. A data gap exists in that the use of the EV-CEMF riparian area mapping is not of sufficient scale for site-specific project planning; however, does provide an estimate of the area of impact in a greater regional context.

Old Growth and Mature Forest

Old growth and mature forest conditions were evaluated for the Project using the Project TEM, which maps these forests through the structural stage attribute (Appendix 13-A). The structural stage attribute was determined using field data that assessed field attributes such as tree diameter and height, tree density, and canopy structure to estimate stand age and then using the image signature of these stands to attribute structural stage for stands not visited on the ground.

Mean patch size and patch size distribution, CWD (mean overall volume and volume by size class), and snag density (mean overall abundance per ha and abundance by size class) are presented by BGC unit and dry, intermediate, and wet ecosystem type. Old growth and mature forests were mapped using the following definitions:

- Mature forests are those where the bulk of the tree canopy is >100 years old in the MSdw and >120 years old in the ESSFdk1 and ESSFdkw; and
- Old forest corresponds to areas where the bulk of the tree canopy is >140 years old.

VRI data does not cover some private land areas of the Landscapes and Ecosystems LSA and as such, presents a data gap in the review. For these areas, photo interpretation was used to differentiate old growth and mature forest after obtaining an air photo signature for old forest from areas with VRI data. Results are also compared to EV-CEMF (Holmes et al., 2018) figures for the RSA. EV-CEMF measured old and mature by BGC unit and Landscape Unit (LU).
The area of old and mature forest was calculated in two ways:

- Entire mature/old polygons (no buffering of edges); and
- Interior mature/old polygons (edges buffered by 100 m).

The method employed by EV-CEMF (2018) was used to delineate interior patches. Determining the number and size of interior patches is important for wildlife species that may be prone to edge effects. Patch size distribution follows that used by EV-CEMF. Data is summarized for the following classes:

- <1 ha;
- 1-5 ha;
- 5-10 ha;
- 10-20 ha;
- 20-40 ha;
- 40-80 ha;
- 80-120 ha;
- 120-250 ha; and
- >250 ha.

Classes are then aggregated into the larger classes (<40 ha, 40-80 ha, 80-250 ha, 40-250 ha, 250-1,000 ha) used by the provincial government (Province of B.C., 1995) and EV-CEMF (EV-CEMF, 2018) to interpret this information.

13.5.2.1.2 Wetland Ecosystems

Wetland Ecosystems Baseline Assessment

Wetland baseline ecosystem surveys were conducted in 2017, 2018, and 2019 to obtain information on wetland presence within the Terrestrial LSA and to determinate wetland classification and conservation ranking (Appendix 13-B). Information on wetland classification, location, size, and function (i.e., biochemical, hydrological, and biological [ecological]) was collected as part of the wetland ecosystem surveys. Wetlands surveyed were situated across several watersheds in the Terrestrial LSA, including Alexander Creek, West Alexander Creek, Grave Creek, Harmer Creek, and the Elk River.

An initial desktop review was conducted prior to wetland field surveys to guide the assessment of wetland ecosystems within the Terrestrial LSA. As part of the desktop evaluation, data from baseline programs (e.g., bird community, amphibians, and TEM) were used to indicate the location of wetlands in the Terrestrial LSA, in conjunction with available aerial imagery (ESRI, 2019). Wetlands identified for assessment in the Terrestrial LSA included all wetlands discernable on aerial photographs and additional areas encountered as part of other Project baseline surveys. Given the size of the Terrestrial LSA and access constraints (e.g., health and safety), not all wetlands within the Terrestrial LSA were documented as part of the field surveys. The extensive field coverage for the baseline assessment suggests few or no wetland types or classes were excluded.

Methods employed for the wetland ecosystem surveys were based on information gathered from the following publications:

- Describing and Identifying Site Units (MacKenzie and Moran, 2004);
- Field Manual for Describing Terrestrial Ecosystems (B.C. Ministry of Forests and Range and B.C. MOE, 2010);
- Sampling Rare and Elusive Species (Poon and Margules, 2004);
- Predicting Occurrences of Geographically Restricted Rare Floral Elements with Qualitative Habitat Data (MacDougall and Loo, 2002);
- Sampling Rare Populations (Mcdonald, 2004); and
- Wetland Ecology: Principles and Conservation (Keddy, 2010).

The Canadian Wetland Classification System (National Wetlands Working Group [NWWG], 1997) was also used for the wetland ecosystems baseline program.

Plot sampling for vegetation, vegetation identification (on-site and from collected specimens), and soil sampling were conducted at each wetland ecosystem surveyed. Information on other characteristics such as zonation, transition, and wetland boundaries was also collected. Wetland ecosystem surveys followed publications outlined above and involved “walk-through surveys” and meanders to determine general and specific vegetative and physical characteristics, gather information on the occurrence (distribution and abundance) of common and characteristic plant species, and to document uncommon and rare plant species. Additional details on methods used in the wetland ecosystem baseline program are provided in Appendix 13-B.

To assess the ecology of the wetlands for the baseline program, the following information was gathered at each wetland surveyed:

- Soils - cores taken to determine soil type (mineral or organic) and the characteristics of each including composition, decomposition, texture, depth and to confirm the presence of hydric soils;
- Landscape position, characteristics, and hydrological connectivity;
- Riparian vegetation and proximity to human-created features (e.g., roads, clearings);
- Vegetation composition – characteristic plant type and species, i.e., those that defined the plant community, presence of hydrophytic vegetation;
- Rare plants – detailed surveys for rare plants were not conducted; rather, plants that made up a major component of the community were noted and some time was allotted to searching for unusual species for wetlands that were uncommon in the Project area (e.g., bogs, calcium-rich deposits, and some fens with unusual/uncommon species assemblages);
- Invasive plant species; and
- Incidental sightings of animals (e.g., mammals, birds, amphibians).

Information on water quality at wetlands surveyed was also gathered to inform the Project human health and ecological risk assessment and is not presented in Chapter 13 (refer to Chapter 22). In-situ water quality was gathered at selected wetlands through use of a multi-meter probe with collected parameters including water clarity, temperature, specific conductivity, conductivity, total dissolved solids, salinity, dissolved oxygen, pH, and turbidity. Surface catchment areas for surveyed wetlands were estimated using an available LiDAR 2 m Digital Elevation Model (DEM). Catchment areas show surface water contributions to surveyed wetland ecosystems and contributed to a wetland ecosystem function assessment.

The conservation status for wetland site associations was determined using available B.C. CDC data, as well as information specific to wetlands in the East Kootenay, such as their relative frequency of occurrence based on descriptors such as “uncommon” or “rare” (i.e., MacKillop et al. [2018]). Wetland classification and conservation status ranking was based on the following:

- A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia. The East Kootenay (MacKillop et al., 2018);
- Wetlands of British Columbia (McKenzie and Moran, 2004);
- Canadian Wetland Classification System (NWWG, 1997); and
- B.C. CDC iMap and the B.C. Species and Ecosystems Explorer.

Wetland Functional Assessment

A wetland ecological functions assessment was completed to identify functions associated with wetlands that have the potential to be directly and indirectly affected by Project activities and to determine the functional capacity of potentially affected wetlands (i.e., how well functions are carried out at each wetland; Appendix 13-D). The wetland ecological functions assessment served as a supplementary assessment to the Wetland Ecosystem Baseline Report (Appendix 13-B). The hydrogeomorphic approach to wetland ecological functional assessments, which groups functions into physical, chemical, and biological wetland processes (Hanson et al., 2008), was used to assess the function of wetlands in the Terrestrial LSA (Table 13.5-4; Granger et al., 2005; Hanson et al., 2008; Minnesota Board of Water and

Soil Resources, 2010; NovaWet, 2011; and Guidugli-Cook et al., 2017). The hydrogeomorphic approach groups wetland functions into hydrological, biochemical, and habitat process categories, which are influenced by:

- Landscape position (geomorphic setting), which may include slope, depressions, flats;
- Water source, including how water enters the wetland (e.g., precipitation, ground- and surface-water); and
- Direction and energy of water flowing through the wetland (Davis et al., 2013).

Table 13.5-4: Overview of Wetland Hydrogeomorphic Functions and Associated Values (after Hanson et al., 2008)

Functional Category	Function	Value
Hydrological	• Surface water storage and release, short- and long-term • Subsurface water storage and release, short- and long-term • Groundwater flow • Water energy/flow	• Dissipate and reduce energy, prevent and control erosion; sediment drop out • Moderate flood water extremes, climate • Replenish groundwater • Moderate flow and discharge • Erosion control • Moderate climate
Biochemical	• Cycling of nutrients through abiotic and biotic processes • Retention of inorganic and organic particles through chemical or physical processes • Export of organic carbon: dissolved or suspended • Production of biomass (sequestration and storage of carbon) • Decomposition of biomass • Production of soils	• Affects element states, availability, and export • Improved water quality by removal of elements and compounds such as nutrients and pollutants • Sequestration and storage of carbon
Habitat	• Plant/algae and animal communities • The presence and maintenance of conditions required by species of plants, algae, and animals • Biological productivity and diversity	• Sustain biodiversity • Provide habitat for rare species and communities • Provide human cultural amenities through hunting, harvesting, and recreation

Primary wetland functions were identified for the five wetland classes documented within the Terrestrial LSA (Table 13.5-5). Each hydrological, biochemical, and habitat function was ranked based on the capacity of the wetland class to perform the function as identified by MacKenzie and Moran (2004), Granger et al. (2005), Hanson et al. (2008), and NovaWet (2011), as well as data collected as part of the wetland ecosystem baseline assessment (Dillon, 2020). Ratings of “low”, “moderate”, and “high” indicate the functional capacity, or the level of performance of a particular function. For example, the capacity or “ability” of a wetland to store water may be low if the wetland is shallow and small, or high if the wetland is deep and extensive. Where necessary, two descriptors were combined to indicate a range of possible functions when the function cannot be related solely to conditions of the wetland type. Functions that perform independently of wetland type are noted by the phrase, “not related to wetland type”. Since the capacity of a wetland to perform a function may vary between wetland types, within wetland types, and

Table 13.5-5: Summary of Wetland Functions by Wetland Classes (based on information by Hanson et al., 2008, MacKenzie and Moran, 2004; Granger et al., 2005; Hanson et al., 2008; NovaWet, 2011; and Dillon, 2020)

Function		Capacity of Wetland to Perform Function				
		Bog	Fen	Marsh	Swamp	Shallow Open Water
Hydrological						
Waterflow moderation/reduction in peak flows		Nil-low	Low-Moderate	Low-High	Moderate-High	Low-Moderate
Surface water detention		Moderate	Moderate	Moderate-High	Moderate-High	Moderate-High
Groundwater recharge		Low	Low-Moderate	Low-Moderate	Low	Unknown
Shoreline stabilization/erosion reduction		Low	Low	Moderate-High	Moderate-High	Low
Climate (local/micro) regulation		Low	Low-Moderate	Moderate-High	Moderate	Moderate
Biochemical						
Water quality treatment		High	Moderate-High	High	Moderate-High	Moderate-High
Nutrient transformation (cycling)		Moderate	High	High	High	Moderate
Nutrient and organic matter export		High	Moderate-High	Moderate-High	Low-Moderate	Low
Carbon sequestration and storage		High	Moderate-High	Low-Moderate	Low-Moderate	Low
Sediment and particulate retention (i.e., prevent downstream movement)		Nil-Low	Low	High	High	Moderate-High
Nutrient removal (phosphorus)		Nil-Low	Low	High	High	Moderate-High
Nutrient removal (nitrogen)		Not related to wetland type	Not related to wetland type	Not related to wetland type	Not related to wetland type	Not related to wetland type
Pollutant removal (i.e., metals, toxins)		High	High	Moderate-High	Moderate-High	Moderate-High
Habitat						
Organisms, general (e.g., specialized and significant species, species at risk)		High	Moderate-High	Moderate-High	Low-High (variable)	Unknown/variable
Organisms	Invertebrates	Moderate-High	Moderate-High	High	Moderate	Moderate-High
	Fish	Nil	Low	High-Moderate	Low-Moderate	Moderate-High
	Amphibians	Low	Moderate	High	Low-Moderate	High
	Birds (water associated)	Low	Low-Moderate	High	Moderate-High	Moderate

Function		Capacity of Wetland to Perform Function				
		Bog	Fen	Marsh	Swamp	Shallow Open Water
	Mammals	Low-Moderate	Moderate-High	Moderate-High	Moderate-High	High
	Native plant species richness	Low-Moderate	Moderate-High	Low	Moderate-High	Low
	Rare/uncommon native plant species	Moderate-High	Moderate-High	Low-Moderate	Moderate	Low-Moderate
	Rare/uncommon native plant community	Moderate-High	Moderate-High	Moderate	Moderate-High	Moderate
	Non-native species richness	Low	Low	Moderate	Low	Moderate

between wetlands of different locations, these functional indices indicate how wetland ecological functions for wetlands of a certain type are likely to perform, not how they will perform for a particular wetland.

The capacity of wetlands to perform certain functions is related to site-specific factors that vary between wetlands and within wetlands of the five major wetland classes (i.e., bog, fen, marsh, swamp, and shallow water; Gopal, 1999; Granger et al., 2005; Hanson et al., 2008; and NovaWet, 2011). Wetland classes can be characterized by their ability to perform certain hydrological, biochemical, and habitat functions. The type of functions performed and the ability of each wetland to perform certain functions varies between wetlands since each wetland is influenced by conditions and stressors specific to each site and environmental setting.

13.5.2.2 Results

13.5.2.2.1 Terrestrial Ecosystem Surveys and Mapping

The Project TEM was used to map and quantify avalanche chutes, grasslands, riparian habitat, old growth and mature forest, as well as wetlands. Supplemental wetland mapping was conducted using alternative methods described in Section 13.5.2.1.2. The TEM was also used to refine the riparian ecosystem mapping that was derived from the EV-CEMF. A total of 936 polygons were delineated across 12,886 ha of the Landscapes and Ecosystems LSA, for an average polygon size of 13.8 ha (Appendix 13-A; Figure 13.5-1; Table 13.5-6). Most polygons delineated occur in the MSdw (n=363), with the lowest number of polygons in the ESSFdkp (n=67). The MSdw occupies the largest area of the Landscapes and Ecosystems LSA, at 6,064 ha. Of the 217 plots completed within the Landscapes and Ecosystems LSA, most of the sampling (89%) occurred in the two BGC units, namely the MSdw and the ESSFdk1.

TEM ecosystem surveys ranged from valley bottom to ridge tops and a full suite of sites were sampled, apart from the ESSFdkp that was not accessible from the ground. The plot sampling ratio of ground plots to visuals was close to 1:1; a higher proportion of ground plots were established than were planned (1:3). The sampling intensity level was three on an area basis (Province of B.C., 1998). The resulting sample intensity was one plot per 59 ha, which is within the one plot per 30-59 ha range provided in the TEM standard (Province of B.C., 1998).

Table 13.5-6: Summary of TEM Polygons

Biogeoclimatic (BGC) Unit	Number of Polygons	Area (ha)	% of Landscapes and Ecosystems LSA	Mean Polygon Area (ha)	Ground Plots	Visual Plots	Total Plots
MSdw	363	6,064	47	16.7	60	53	113
ESSFdk1	350	4,704	37	13.4	26	54	80
ESSFdkw	156	1,554	12	10.0	11	13	24
ESSFdkp	67	564	4	8.4	0	0	0
Total	936	12,886	100	13.8	97	120	217

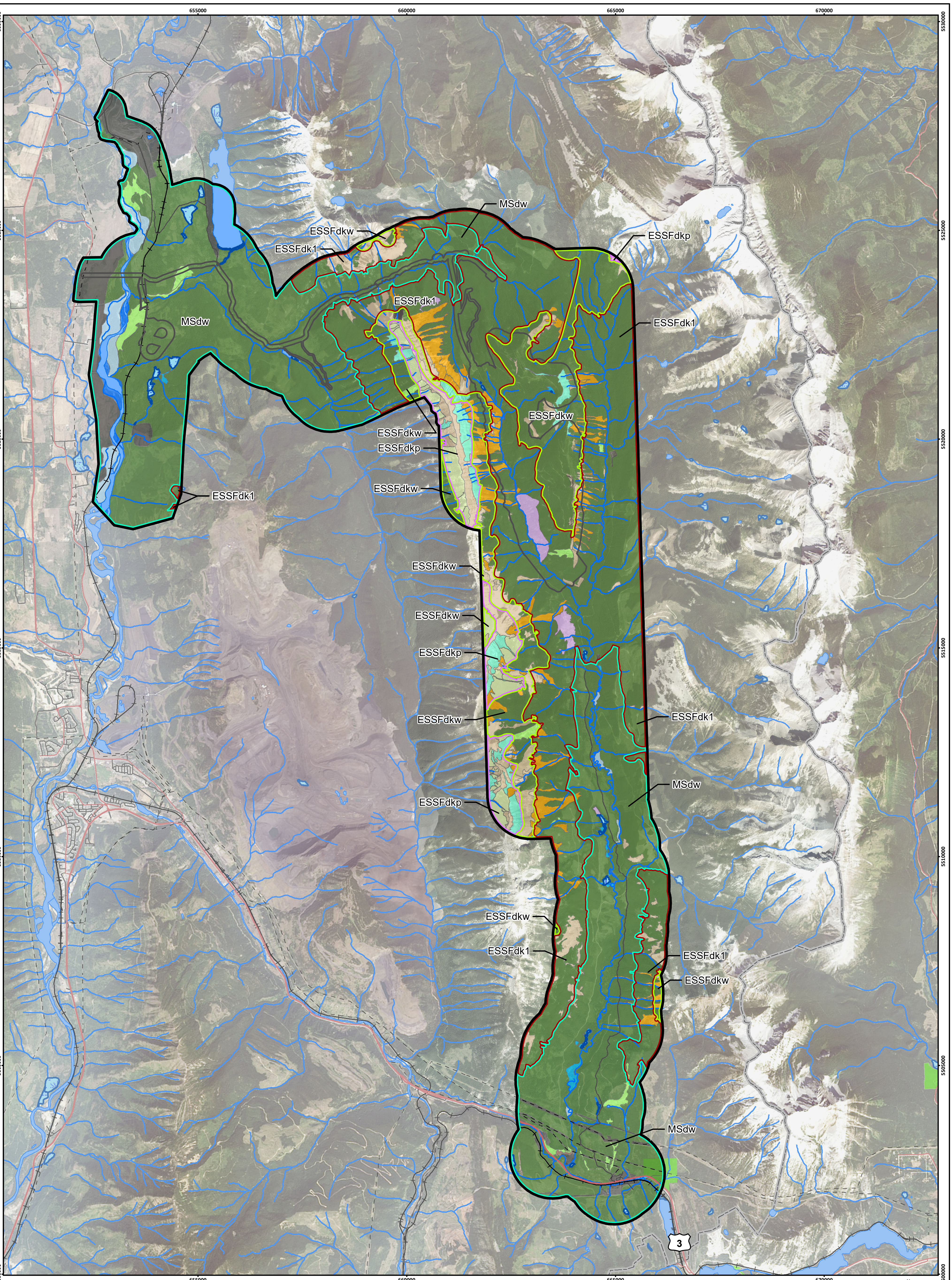

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Figure 13.5-1

Terrestrial Ecosystem Mapping Biogeoclimatic Units of the Landscapes and Ecosystems LSA

LEGEND

Biogeoclimatic Ecosystem Group
- Alpine
- Anthropogenic
- Avalanche
- Disclimax
- Exposed Soil
- Floodplain
- Forest
- Grassland
- Rock
- Subalpine
- Water
- Wetland

Biogeoclimatic Zone
- ESSFdk1
- ESSFdkp
- ESSFdkw
- MSdw

- Landscapes and Ecosystems 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

0 2 4
Kilometres

N E S W

Scale 1:85,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, 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: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

Project: 12-6231

Status: FINAL

Date: 2022-01-11

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The Project TEM predicts avalanche chutes occur across 69 ha or 5% of the Project footprint, and in 603 ha or 5% of the Landscapes and Ecosystems LSA. Grasslands are predicted to occur across 13 ha or 1% of the Project footprint, and in 200 ha or 2% of the Landscapes and Ecosystems LSA. Old growth and mature forest occur across 851 ha or 66% of the Project footprint, and 5,029 ha or 39% of the Landscapes and Ecosystems LSA. Riparian habitats are predicted across 78 ha or 6% of the Project footprint, and in 1,318 ha or 9% of the Landscapes and Ecosystems LSA. The Project TEM predicts wetlands cover less than 1 ha and less than 1% of the Project footprint, and in 122 ha or 1% of the Landscapes and Ecosystems LSA. These metrics are displayed in Table 13.5-7. For additional details on the TEM baseline survey methods, refer to Appendix 13-A.

Table 13.5-7: Terrestrial Ecosystem Mapping Landscape and Ecosystem VCs in the Project Footprint and Landscapes and Ecosystems LSA

Valued Component (VC)	Amount in Landscapes and Ecosystems LSA		Amount in Project Footprint		Change as a % of the Landscapes and Ecosystems LSA
	Area (ha)	% of Landscapes and Ecosystems LSA	Area (ha)	% of Project Footprint	
Avalanche Chutes	603.13	4.68	69.39	5.41	11.50
Grasslands	200.11	1.55	12.47	0.97	1.55
Old Growth and Mature Forest[1]	5,231.12	40.60	916.97	71.47	17.53
Riparian Habitat	1,137.77	8.83	78.39	6.11	6.89
Wetlands	122	0.95	0.69	0.05	0.57

Note:

1. Represents the forested land base (ecosystems with the potential to produce forests) within the Project footprint and Landscapes and Ecosystems LSA, respectively.

13.5.2.2.2 Avalanche Chutes

Avalanche chutes comprise 603 ha or 5% of the Landscapes and Ecosystems LSA (Table 13.5-8; Figure 13.5-2). The total area of avalanche chutes within the Project footprint is approximately 69 ha, or 5% of the Project footprint. The total area of avalanche chutes within the Project footprint is approximately 12% of the avalanche chutes within the Landscapes and Ecosystems LSA. Map unit names and full descriptions of the avalanche chute map entities are outlined in Table 13.5-8, and are available in the TEM Report in Appendix 13-A.

Sixty-six (66) percent of the avalanche chute area in the Landscapes and Ecosystems LSA is found in the ESSFdk1, followed by the ESSFdkw and ESSFdkp with 26% and 5% of the avalanche chute areas in the Landscapes and Ecosystems LSA, respectively. Given the respective upper elevation limits, only 2% of all avalanche chutes in the Landscapes and Ecosystems LSA are found in the MSdw. Shrub thickets (Vs) are the most widespread unit, accounting for 58% (348 ha) of the total avalanche chute area in the Landscapes and Ecosystems LSA. Treed avalanche chutes were the second most abundant ecosystem type at 26% (159 ha) of all avalanche chutes. Herbaceous avalanche chute type meadows (Vh) covered 96 ha or 16% of all avalanche chutes mapped in the Landscapes and Ecosystems LSA.

Table 13.5-8: Avalanche Chute Areas in the Landscapes and Ecosystems LSA and Project Footprint by BGC Unit and by Site Series

TEM Map Unit[1]	Landscapes and Ecosystems LSA Extent (ha)	% of Landscapes and Ecosystems LSA	Project Footprint Extent (ha)	% of Project Footprint	% of Map Unit Affected
MSdw					
Vhm	0.80	0.01	0.00	0.00	0.00
Vs	7.88	0.06	0.00	0.00	0.00
Vt	5.44	0.04	0.11	0.01	1.98
Subtotal - MSdw	14.13	0.11	0.11	0.01	0.76
ESSFdk1					
Vhd	11.89	0.09	4.87	0.38	40.94
Vhm	33.27	0.26	8.21	0.64	24.69
Vh01	4.89	0.04	1.63	0.13	33.38
Vs	238.64	1.85	33.26	2.59	13.94
Vs10	7.52	0.06	0.00	0.00	0.00
Vt	101.85	0.79	6.65	0.52	6.53
Subtotal – ESSFdk1	398.05	3.09	54.62	4.26	13.72
ESSFdkw					
Vh	0.05	<0.01	0.00	0.00	0.00
Vhd	25.52	0.20	3.33	0.26	13.03
Vhm	12.28	0.10	2.42	0.19	19.75
Vh01	0.00	0.00	0.00	0.00	0.00
Vs	78.74	0.61	8.71	0.68	11.07
Vs10	0.00	0.00	0.00	0.00	0.00
Vt	42.83	0.33	0.20	0.02	0.46
Subtotal - ESSFdkw	159.42	1.24	14.66	1.14	9.20
ESSFdkp					
Vhd	7.34	0.06	0.00	0.00	0.00
Vs	15.65	0.12	0.00	0.00	0.00
Vt	8.54	0.07	0.00	0.00	0.00
Subtotal - ESSFdkp	31.53	0.24	0.00	0.00	0.00
Subtotal – Vh Map Units	96.04	0.75	20.47	1.60	21.31
Subtotal - Vs Map Units	348.03	2.70	41.97	3.27	12.06
Subtotal - Vt Map Units	158.66	1.23	6.95	0.54	4.38
Total	603.13	4.68	69.39	5.41	11.50

Note:
1. Description of map units provided in Table 13.5-15

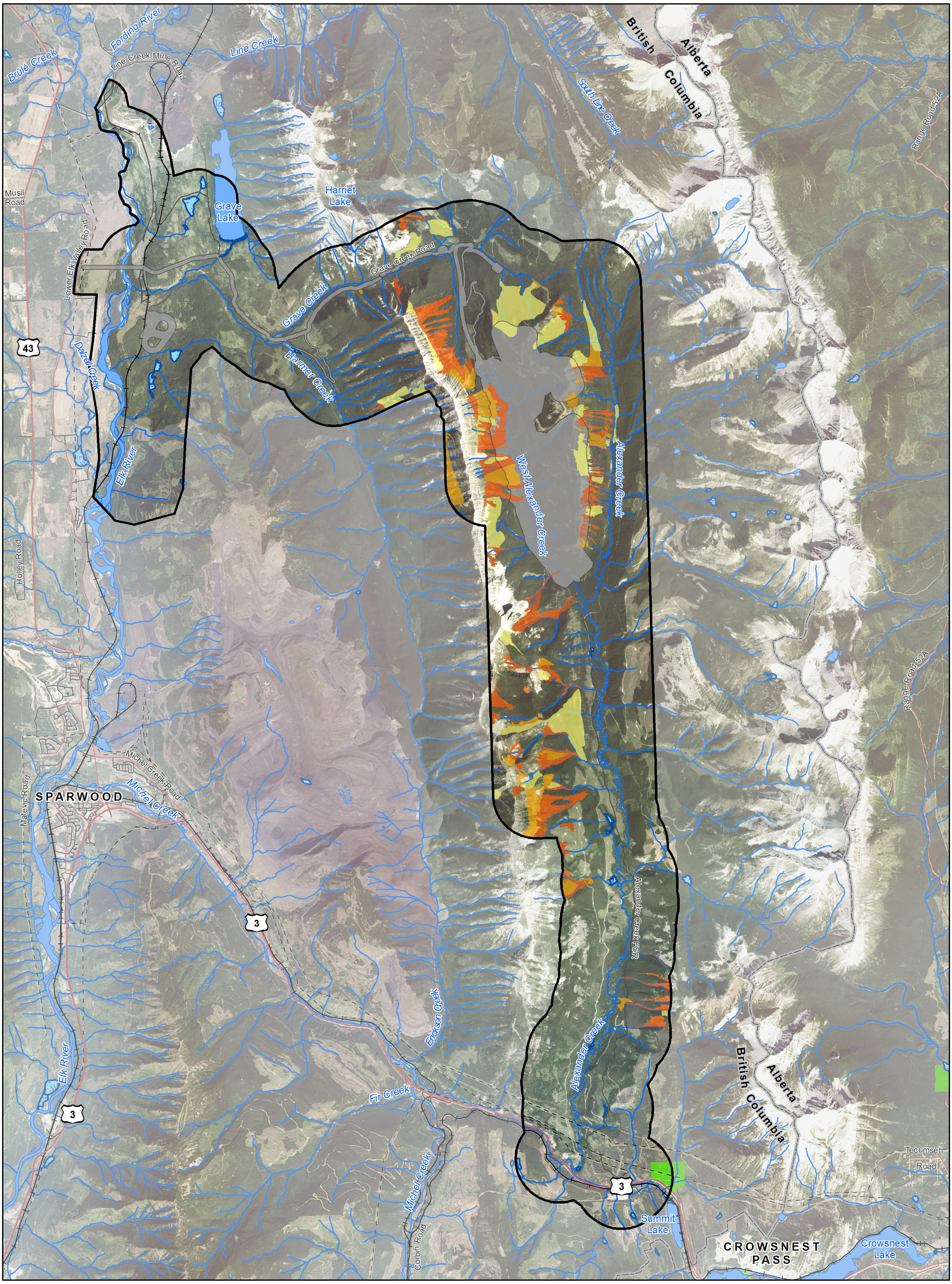

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Figure 13.5-2
Avalanche Chute Ecosystems in the Landscapes and Ecosystems Local Study Area

LEGEND

- Avalanche Chute Ecosystem (Dominant)
- Avalanche Chute Ecosystem (Codominant)
- Avalanche Chute Ecosystem (Subdominant)
- Landscapes and Ecosystems 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 1:85,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, 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/PR
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

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Status: FINAL
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Avalanche chutes can be herb, shrub, or small tree dominated. Large and mature trees are generally destroyed in larger or frequently active avalanche paths, leaving earlier seral communities to persist. Avalanche chutes provide a unique set of growing conditions in comparison to conditions in surrounding forests, with highly variable moisture, sunlight, and snowpack (MacKillop et al., 2018). Due to the wide variety of microsites found in avalanche chutes, plant community diversity tends to be extremely high both within a single avalanche chute and between avalanche chutes and the adjacent ecosystems (MacKillop et al., 2018). Some of the more common plant species in avalanche paths include Sitka alder (Alnus alnobetula spp. sinuata), willows (Salix spp.), thimbleberry (Rubus parviflorus), fireweed (Epilobium angustifolium), cow-parsnip (Heracleum maximum), ferns, and grasses (MacKillop et al., 2018). Structure and composition data from "A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia, The East Kootenay" (MacKillop et al., 2018) are detailed in Table 13.5-9 for the avalanche ecosystem classes found in the Landscapes and Ecosystems LSA.

There were no invasive plants detected in avalanche chute ecosystems during the invasive plant and Project TEM surveys.

13.5.2.2.3 Grasslands

Grassland ecosystems are relatively uncommon within the Landscapes and Ecosystems LSA. Due to the relatively cool and moist climate, grasslands are primarily restricted to warm aspect, upper slope, well drained sites. The most extensive low elevation grassland within the Landscapes and Ecosystems RSA is found within the Landscapes and Ecosystems LSA at Grave Prairie, a level river terrace located south of the confluence of Grave Creek and the Elk River. High elevation grasslands are relatively widespread on warm aspects to the east and north of Elkford within the Elk Valley. This is an unusual occurrence for B.C. and is not seen in the Landscapes and Ecosystems LSA. The extent of grasslands within the Project footprint and Landscapes and Ecosystems LSA is summarized in Table 13.5-10.

Grassland ecosystems comprise approximately 1.55% (200 ha) of the Landscapes and Ecosystems LSA and 0.97% (13 ha) of the Project footprint (Table 13.5-10; Figure 13.5-3). Within the Landscapes and Ecosystems LSA, 83% (166 ha) of grassland ecosystems are characterized as brushlands, while 16% (33 ha) are characterized as typic grasslands, and less than 1% (2 ha) are characterized as saline meadow. The majority (73%) of grasslands found in the Landscapes and Ecosystems LSA are located at low elevations in the MSdw BGC Unit. The remainder of grasslands are split between the ESSFdk1 (15%) and ESSFdkw (13%) BGC Units. Alpine grasslands are not found in the Landscapes and Ecosystems LSA.

Grassland composition in the Landscapes and Ecosystems RSA is substantially different than the Landscapes and Ecosystems LSA. While the overall proportion of grassland ecosystems within the Landscapes and Ecosystems RSA is similar to the Landscapes and Ecosystems LSA at 2% of total land area, grassland site types are more abundant relative to brushland site types at 60% and 40%, respectively. The elevation of grasslands is distinctly different in the Landscapes and Ecosystems RSA relative to the Landscapes and Ecosystems LSA, where valley bottom BGC units account for only 14% of all grasslands in the Landscapes and Ecosystems RSA, compared to 73% of grasslands in the Landscapes and Ecosystems LSA. Within the Landscapes and Ecosystems RSA, the largest proportion of the landscape comprised of grassland is found at elevations above 1,900 m asl.

Table 13.5-9 Structural and Compositional Details of Avalanche Chutes Found in the Landscapes and Ecosystems LSA

Ecosystem Name	Class	Structure and Composition[1]	Landscapes and Ecosystems LSA		Project Footprint	
			Area (ha)	%	Area (ha)	%
Herbaceous Meadow Avalanche Chute (Vh)						
Avalanche dry herb meadow	Vhd	These ecosystems are dominated by forbs (i.e., Structural Stage 2a) such as yarrow (Achillea millefolium) or strawberry (Fragaria virginiana), graminoid fescues (Festucs spp.), and/or dwarf woody shrubs (i.e., Structural Stage 2d) such as grouseberry or low bilberry (Vaccinium myrtillus). Snow movement limits the establishment of trees in these ecosystems.	44.75	0.35	8.19	0.64
Avalanche moist herb meadow	Vhm	These ecosystems are dominated by lush forbs (i.e., Structural Stage 2a) such as cow-parsnip, false-hellebore (Veratrum viride), Sitka valerian (Valeriana sitchensis), and/or graminoids (i.e., Structural Stage 2b), such as blue wildrye (Elymus glaucus) and bluejoint reedgrass (Calamagrostis canadensis). Moist herb meadows tend to occur in runout zones where snow accumulation and snowmelt create moist conditions.	46.35	0.36	10.64	0.83
Cow-parsnip – fireweed – nettle avalanche herb meadow	Vh01	Cow-parsnip is usually found with abundant fireweed and varying amounts of stinging nettle and meadowrues (Thalictrum spp). Bluejoint reedgrass can have high cover but may be absent depending on which of the two variants are found. Typically forb-dominated or graminoid dominated Structural Stages (i.e., 2a and 2b, respectively).	4.89	0.04	1.63	0.13
Avalanche herb meadow (unspecified)	Vh	These ecosystems are dominated by diverse forb communities (i.e., Structural Stage 2a) that vary depending on location within the avalanche path and position within the landscape. These are areas that were not classified specifically to dry or moist variants.	0.05	<0.01	0.00	0.00
		Subtotal – Avalanche Herb Meadow	96.04	0.75	20.47	1.60

Ecosystem Name	Class	Structure and Composition[1]	Landscapes and Ecosystems LSA		Project Footprint	
			Area (ha)	%	Area (ha)	%
Shrub Thicket Avalanche Chute (Vs)						
Avalanche shrub thicket	Vs	These ecosystems are dominated by deciduous shrubs (i.e., Structural Stage 3a) such as alder (Alnus spp.), willows, thimbleberry with alder absent, black huckleberry (Vaccinium membranaceum), and saskatoon (Amelanchier alnifolia). Most frequently associated with the track and lateral runout portions of the avalanche path where deep snow lay occurs infrequently, but site conditions are fresh or wetter.	340.91	2.65	41.97	3.27
Willow – cow-parsnip – fireweed -avalanche shrub thicket	Vs10	Sites are often associated with runout zones adjacent to wetlands and riparian areas, but can also occur on moist, lower avalanche slopes. Vs10 sites are dominated by willows—usually Sitka or Barclay's (Salix barclayi) (i.e., Structural Stage 3a) —and commonly contain black twinberry (Lonicera involucrata), fireweed, cow-parsnip, western meadowrue (Thalictrum occidentale), valerian, and stinging nettle	7.52	0.06	0.00	0%
		Subtotal – Avalanche Shrub Thicket	348.43	2.70	41.97	3.27
Treed Avalanche Chute (Vt)						
Avalanche treed	Vt	These ecosystems are dominated by shrub-sized0 trees (i.e., Structural Stages 3b, 4, 5) which are maintained by snow slides which function as continuous pruning. Repeat exposure to avalanches prevents these ecosystems from progressing to forests. This does not include young forests recovering from a single extreme avalanche event.	158.66	1.23	6.95	0.54

Note:
1. Summarized from MacKillop et al., 2018.

Table 13.5-10: Grassland Ecosystems Identified in the Project Footprint and Landscapes and Ecosystems LSA

BGC Unit	Grassland Ecosystem Class[1]	Project Footprint Extent (ha)	Project Footprint Extent (%)	Landscapes and Ecosystems LSA Extent (ha)	Landscapes and Ecosystems LSA Extent (%)
MSdw	Ga03$	0.00	0.00	1.87	0.01
	Gb	1.35	0.11	52.26	0.41
	Gb04	0.36	0.03	58.41	0.45
	Gg	0.02	0.00	5.93	0.05
	Gg12	1.07	0.08	26.75	0.21
ESSFdk1	Gb	0.00	0.00	6.21	0.05
	Gb20	6.78	0.53	23.30	0.18
ESSFdkw	Gb20	2.89	0.23	25.38	0.20
Subtotal	Ga03$	0.00	0.00	1.87	0.01
	Gb	1.35	0.11	58.47	0.45
	Gb04	0.36	0.03	58.41	0.45
	Gb20	9.67	0.75	48.68	0.38
	Gg	0.02	0.00	5.93	0.05
	Gg12	1.07	0.08	26.75	0.21
	Total	12.47	0.97	200.11	1.55

Note:

1. Description of Grassland Ecosystem Classes provided in Table 13.5-11.

Within the Landscapes and Ecosystems LSA, grasslands are found in isolated patches, often on warm aspect steep sites with large distances separating them. Connectivity of grasslands is still low in the Landscapes and Ecosystems RSA, with high elevation grasslands found on isolated peaks but primarily on a cluster of ridges north and east of Elkford.

Grassland ecosystems occurring in the Landscapes and Ecosystems LSA include graminoid-dominated grasslands (i.e., shrub species composition is less than 10%), brushlands (i.e., shrub species composition is >10%), and alkaline/saline meadows. The structure and compositional details of grassland ecosystems are detailed in Table 13.5-11. Graminoid-dominated associations (site association Gg) contain tall, mid, and low stature grasses and forbs, with moderately well-developed biological soil crusts. Low stature shrubs such as kinnikinnick are often abundant and medium statured shrubs such as prickly rose (Rosa acicularis) and saskatoon (Amelanchier alnifolia) are found in this association, but are sparse. Brushlands (site class Gb) are commonly dominated by medium statured shrubs such as soopolallie (Shepardia canadensis), saskatoon, common juniper, and prickly rose. Tall, mid, and low stature grasses and forbs are often abundant. Alkaline/saline meadows are commonly disturbed sites in the East Kootenay, as they are often subject to heavy livestock grazing pressure. In undisturbed condition, alkaline/saline meadows are typically dominated by sedges and Baltic rush (Juncus balticus). Grassland ecosystems rarely contain more than sparse composition of tree species; however, successional processes such as fire suppression can lead to forest encroachment.

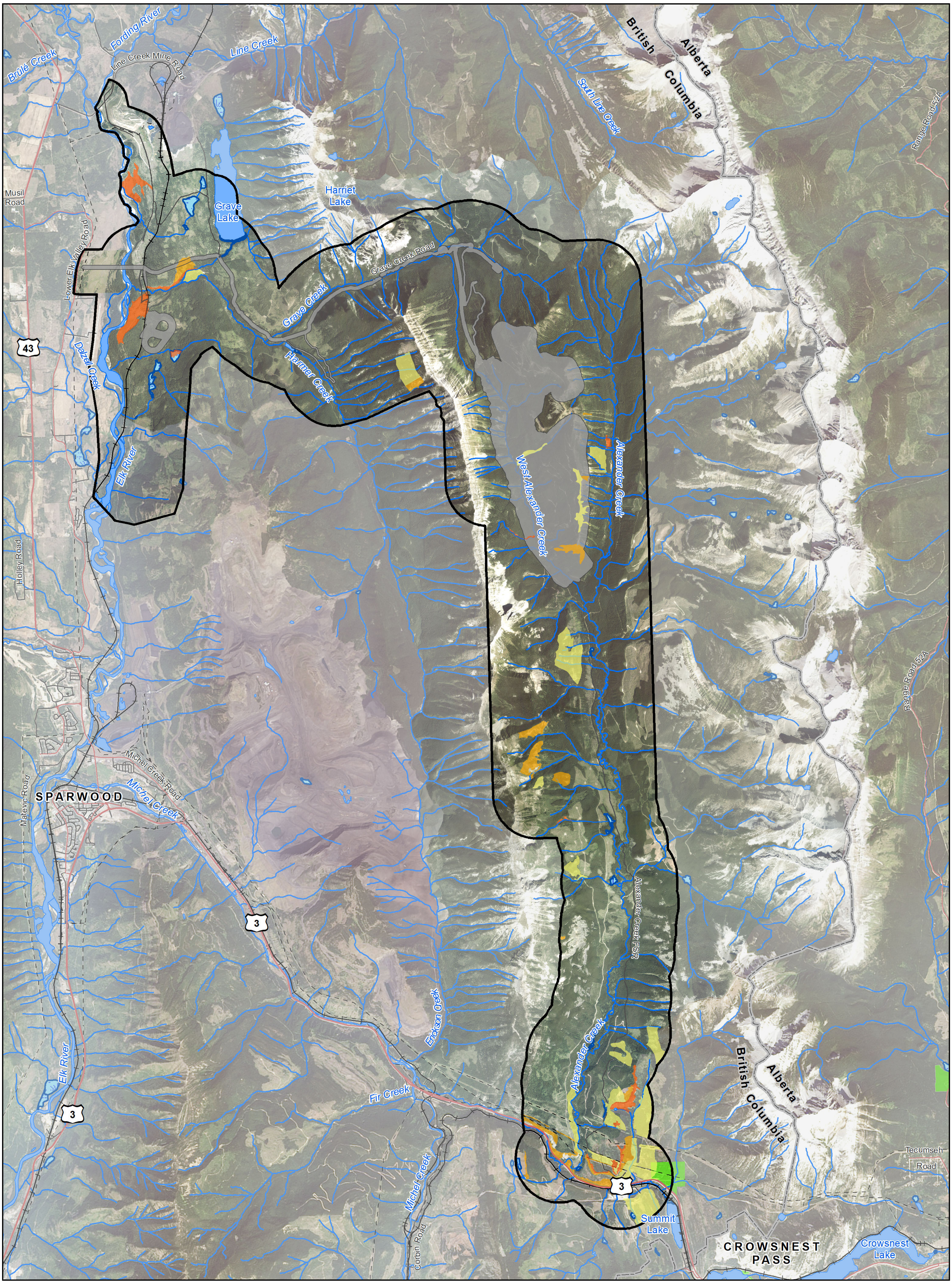

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Figure 13.5-3
Grassland Ecosystems in the Landscapes and Ecosystems Local Study Area

LEGEND

- Grassland Ecosystem (Dominant)
- Grassland Ecosystem (Codominant)
- Grassland Ecosystem (Subdominant)
- Landscapes and Ecosystems 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

0 2 4
Kilometres

Scale 1:85,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, 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/PR/LMM
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Map Coordinate System: NAD 1983 UTM Zone 11N

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Table 13.5-11: Structural and Compositional Details of Grassland Ecosystems Found in the Landscapes and Ecosystems LSA

Ecosystem Name	Class	Structure and Composition[1]	Landscapes and Ecosystems LSA		Project Footprint	
			Area (ha)	% of Total Area	Area (ha)	% of Total Area
Grassland	Gg	These ecosystems are graminoid-dominated associations (i.e., Structural Stage 2b). Within the Landscapes and Ecosystems LSA, low elevation grasslands are more common, and will be dominated with bluebunch wheat grass and rough fescue with associations of needle-and-thread grass (Hesperostipa comata), needlegrasses (Nassella viridula), bluegrasses (Poa spp.), and a variety of forbs. Invasives are known to occur in these grasslands. If shrubs occur, they are sparse (< 10%) or of lower stature than grasses.	5.93	0.05	0.02	<0.01
Field sedge (seral) alkaline grassland	Ga03$	These ecosystems are disturbed moist meadows (i.e., Structural Stage 2b) that typically occur on toe slopes adjacent to wetlands, on sites that are briefly inundated, and are moderately saline. Soils are loamy or fine textured, have little or no coarse fragments, and are usually gleyed. This mapped ecosystem was identified as a seral vegetation community.	1.87	0.01	0.00	0.00
Rough fescue - (bluebunch wheatgrass) - yarrow - clad lichens association	Gg12	These ecosystems are graminoid-dominated associations (i.e., Structural Stage 2b). The dominant grasses are commonly rough fescue with spreading needlegrass (Achnatherum richardsonii), junegrass (Koeleria macrantha), and diverse scattered forbs such as pussytoes (Antenarria spp.), yarrow, nodding onion (Allium cernuum), and yellow penstemon (Penstemon confertus). Kinnikinnick is a low stature shrub that is sometimes present and can be abundant. Scattered rose and saskatoon are common but sparse (<10%). The biological soil crust is moderately well developed and dominated by clad lichens (Cladina spp.), sidewalk screw-moss (Tortula ruralis), and pelt lichens (Peltigera spp).	26.75	0.21	1.07	0.08
Brushland	Gb	Dominated (> 10%) by drought-tolerant woody shrubs of moderate stature (i.e., Structural Stage 3a). Gb was mapped where species composition was unclear and more detailed classification was not possible.	58.47	0.45	1.35	0.11

Ecosystem Name	Class	Structure and Composition[1]	Landscapes and Ecosystems LSA		Project Footprint	
			Area (ha)	% of Total Area	Area (ha)	% of Total Area
Choke cherry – snowberry – bluebunch wheatgrass association	Gb04	These ecosystems are shrub-dominated associations (i.e., Structural Stage 3a). The dominant shrubs are snowberry and choke cherry (Prunus virginiana) with low cover of saskatoon and roses. Choke cherry and snowberry are associated with draws, depressions, gullies, and other moisture-collecting sites. The sparse herb layer is characterized by scattered bluebunch wheatgrass and silky lupine (Lupinus sericeus).	58.41	0.45	0.36	0.03
Saskatoon – soopolallie – juniper brushland association	Gb20	These ecosystems are shrub-dominated associations (i.e., Structural Stage 3a). The dominant shrub cover is saskatoon, common juniper, and soopollalie with minor covers of birch-leaved spirea (Spirea betulifolia) and/or prickly rose. Forbs and grasses are sparse and scattered, and usually consist of strawberry, yarrow, penstemons, and nodding onion. Occasionally, kinnikinnick, pinegrass, and sulphur buckwheat are present.	48.68	0.38	9.67	0.75

Note:
1. Summarized MacKillop et al. (2018).

Within the Landscapes and Ecosystems LSA, 13% (27 ha) of the 200 ha of grassland area is designated as a Red-listed ecological community by the B.C. CDC (Gg12 Rough fescue – [bluebunch wheatgrass] - yarrow - clad lichens [MacKillop et al., 2018]). The Project footprint overlaps a portion of this Red-listed ecological community, which accounts for 1 ha or less than 1% of the overall extent of the Project footprint. The Gg12 ecological community was observed west of the proposed Project rail loadout and east of the Elk River along Valley Road (Figure 13.5-3), in an area fragmented by linear features such as access roads and the CP rail line, and may have been disturbed in the past by logging and land clearing and/or livestock grazing. The dominant grass at this site is the non-native Canada bluegrass, indicating the Gg12 ecological community is not in pristine condition and has likely previously undergone some disturbance.

Species richness is substantially higher in grassland ecosystems compared to the adjoining forested ecosystems based on a qualitative assessment of species lists gathered on both ecosystems, and are estimated to be the most diverse ecosystems encountered in the Landscapes and Ecosystems LSA. Listed and rare plant species found in the Landscapes and Ecosystems LSA, detailed in Table 13.5-12, occurred most often in grassland ecosystems, with four of the six listed plant species found in grassland ecosystems. The four listed species found were ground plum (Astragalus crassicarpus), Drummond's milk-vetch (Astragalus drummondii), shining penstemon (Penstemon nitidus var. nitidus), and Parry's townsendia (Townsendia parryii). All four species are considered to be Red-listed, meaning they are at risk of being lost (B.C. CDC, 2018a). Cusick's paintbrush (Castilleja cusickii) was previously designated as a Red-listed species; however, in 2019 its status was changed to Unknown (B.C. CDC, n.d.). Although this species is not currently provincially-listed, it is important to understand potential impacts to this species as a result of Project activities as the current species conservation listing may change. Cusick's paintbrush was observed in the southern portion of the Landscapes and Ecosystems LSA and east of the proposed rail loadout within the Red-listed Gg12 ecological community west of Valley Road. No endangered high-elevation grasslands listed by SARA were encountered in the Landscapes and Ecosystems LSA. Additional details regarding the listed plants species and ecological community are provided in Chapter 14.

Table 13.5-12: Listed Plant Species Observed in Grassland Habitats within the Landscapes and Ecosystems LSA

Common Name	Scientific Name	Provincial Listing	Habitat	Number of Observations
Ground plum	Astragalus crassicarpus	Red-listed	Dry grassy openings in the montane zone	1
Shining penstemon	Penstemon nitidus var. nitidus	Red-listed	Dry hillsides, grasslands and roadside banks in the montane zone	3
Parry's townsendia	Townsendia parryii	Red-listed	Dry rocky slopes within the alpine zone	1
Cusick's paintbrush	Castilleja cusickii	Unknown	Mesic meadows in the montane zone	2
Drummond's milk-vetch	Astragalus drummondii	Red-listed	Dry, open, grassy slopes in the montane zone	2

Grassland ecosystems are frequently found with small occurrences of invasive plants species in the Landscapes and Ecosystems LSA. Invasive species are defined as any non-native organism that cause economic or environmental harm and can spread quickly to new areas of B.C. (ISCBC, n.d.). The invasive species baseline also noted several “agronomic” non-native grasses and legumes (KES, 2020b). Invasive plant species were identified in eight of ten ground plots sampled within grassland ecosystems. In three plots, the dominant (up to 75% cover) species found on-site were non-native, with Canada bluegrass dominated grasslands in two cases, and Kentucky bluegrass dominated in the other. Both Canada bluegrass sites were found in the Grave Prairie grassland and lower Grave Creek area, while the Kentucky bluegrass dominated site was an alkaline grassland found one km east of the south end of the Grave Prairie grassland. In addition to the occurrence of invasive plant species found on TEM and listed plant species ground plots, there were seven instances of invasive species found occurring adjacent to grassland ecosystems during invasive species surveys. The species found along roads during the invasive plant surveys are frequently distinct from those found on ground plots within the grasslands. A listing of invasive species found within the Landscapes and Ecosystems LSA is provided in Table 13.5-13.

Table 13.5-13: Invasive Species Found in Grasslands Contained in the Landscapes and Ecosystems LSA

Common Name	Scientific Name	Data Source	BC Weed Control Regulation[1]	IPMA Priority (IPMA 02)[2]	Number of Occurrences[3]	Observed range of area cover (%)
Alfalfa	Medicago sativa	Listed plant survey	-	-	1/20	1

Common Name	Scientific Name	Data Source	BC Weed Control Regulation[1]	IPMA Priority (IPMA 02)[2]	Number of Occurrences[3]	Observed range of area cover (%)
Annual sow thistle	Sonchus oleraceus	Invasive species survey	P	4	1/20	n/a
Canada bluegrass	Poa compressa	Listed plant survey	-	-	3/20	5-40
Canada thistle	Cirsium arvense	Listed plant survey	P	4	1/20	2
Curled dock	Rumex crispus	Invasive species survey	-	-	1/20	n/a
Hound's tongue	Cynoglossum officinale	Listed plant and invasive species surveys	P	4	3/20	1
Mustard species	Brassicaceae spp.	Listed plant survey	-	-	5/20	0.01-2
Orchard-grass	Dactylis glomerata	Listed plant survey	-	-	1/20	1
Oxeye daisy	Leucanthemum vulgare	Listed plant survey	-	4	1/20	2
Scentless chamomile	Matricaria maritima	Invasive species survey	P	3	1/20	n/a
Spotted knapweed	Centaurea stoebe	Listed plant and invasive species surveys	P	3	4/20	1
Yellow salsify	Tragopogon dubius	Listed plant and TEM surveys	-	-	4/20	1-2
Yellow toadflax	Linaria vulgaris	Listed plant and invasive species surveys	P	-	6/20	1

Notes:

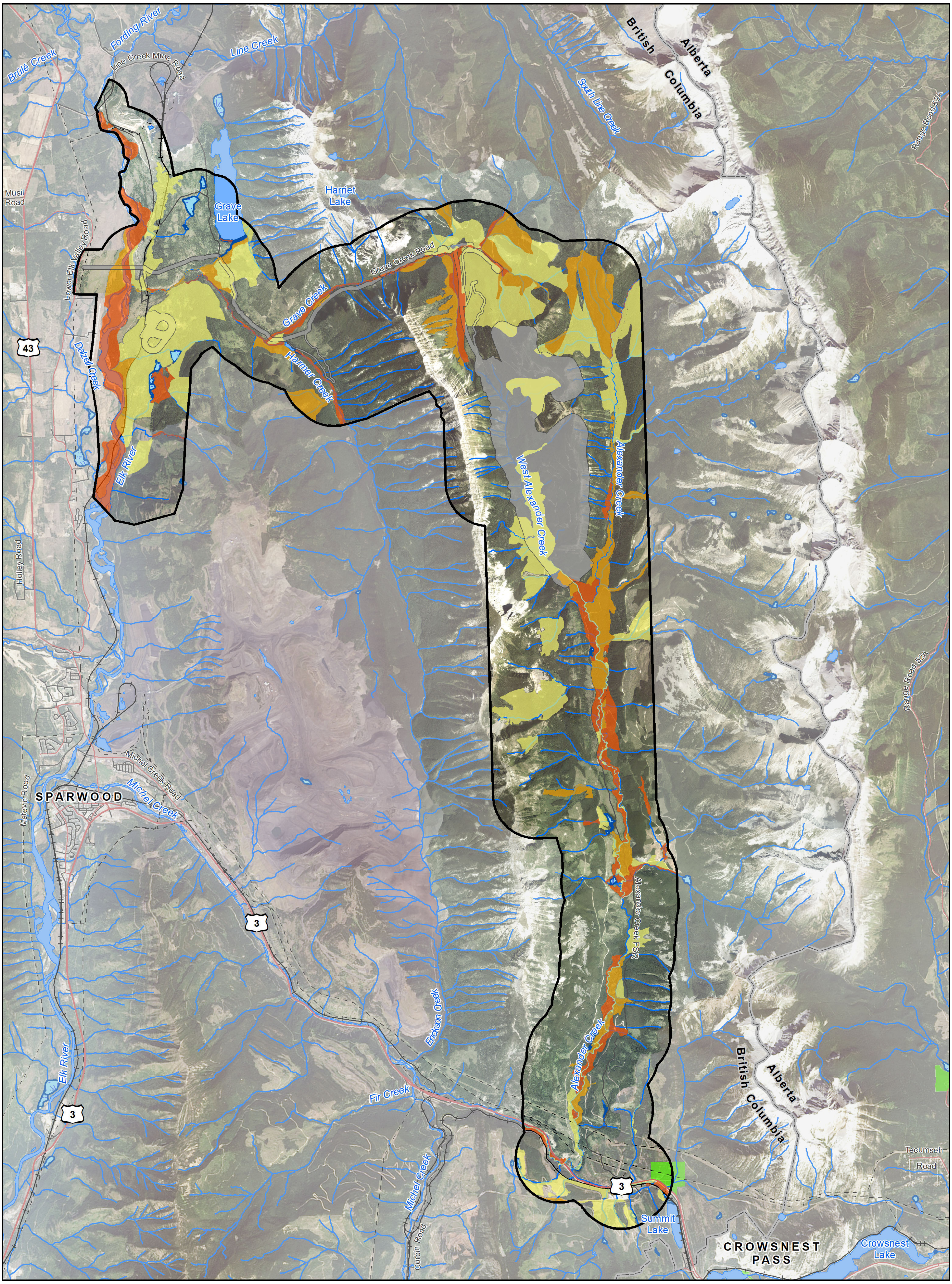
1. P=Provincial Weeds, weeds classified as noxious within all regions of the province; R=Regional Weeds, designated as noxious weeds within the boundaries of the corresponding regional district as per the Weed Control Regulations.

2. Invasive Plant Management Area (IMPA) designated in the East Kootenay Invasive Species Council (EKISC) 2020 Annual Operating Plan (EKISC, 2020) - Priority 1: Eradication, Priority 2: Annual Control, Priority 3: Containment, Priority 4: Established (Biocontrol or site-specific approach), Priority 5. Insufficient Information.

3. Number of occurrences denominator (20) is the number of Project TEM or listed plant ground plots in grassland ecosystems plus the number of invasive plant survey observations adjacent to grassland ecosystems.

13.5.2.2.4 Riparian Habitat

Riparian ecosystems comprise approximately 9% (1,138 ha) of the Landscapes and Ecosystems LSA, with approximately 60% occurring in the MSdw, 36% occurring in the ESSFdk1, 5% occurring in the ESSFdkw, and 0% occurring in the ESSFdkp, as summarized in Table 13.5-14 and illustrated in Figure 13.5-4. Riparian habitats comprise up to 6% of the Project footprint, or up to 7% of the riparian habitat within the Landscapes and Ecosystems LSA.



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Crown Mountain Coking Coal Project

Figure 13.5-4
Riparian Habitat in the Landscapes and Ecosystems Local Study Area

LEGEND

- Riparian Habitat (Dominant)
- Riparian Habitat (Codominant)
- Riparian Habitat (Subdominant)
- Landscapes and Ecosystems Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
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Riparian habitats found in the Landscapes and Ecosystems LSA are primarily dominated by either a tree overstory or tall shrub and low tree overstory located in active channels, annually flooded low-bench floodplain, less frequently flooded mid-bench floodplain, and moist closed canopy conifer forest. Structural and compositional details of riparian ecosystems and their relative abundance are described in Table 13.5-15. Species richness is substantially higher in riparian ecosystems compared to the adjoining forested ecosystems based on a qualitative assessment of species lists gathered in both ecosystems. Riparian site series (110 and 111) had 17 and 18 vegetation species noted, in comparison to 12 species for mesic (101) site series. Riparian habitats are often structurally diverse, with tall and low shrub layers and a lush herb layer. Vegetation species commonly found in the 110 and 111 riparian site series include hybrid white spruce (Picea engelmanii x glauca), subalpine fir (Abies lasiocarpa), false azalea (Menziesia ferruginea), one-leaved foamflower (Tiarella trifoliata), black gooseberry (Ribes lacustre), common horsetail (Equisetum arvense), western meadowrue (Thalictrum occidentale), sharptooth angelica (Angelica arguta), cow-parsnip (Heracleum maximum), and arrow-leaved groundsel (Senecio triangularis). No listed plant species were found within riparian habitat.

Table 13.5-14: Riparian Ecosystems Map Unit Areas in the Landscapes and Ecosystems LSA and Project Footprint

TEM Map Unit[1]	Landscapes and Ecosystems LSA Extent (ha)	% of Landscapes and Ecosystems LSA[2]	Project Footprint Extent (ha)	% of Project Footprint[3]	% of Map Unit Affected
MSdw					
Ff	0.75	0.01	0.00	0.00	0.00
Fl	17.18	0.13	0.00	0.00	0.00
Fl01	4.62	0.04	0.02	<0.01	0.50
Fl04	0.37	<0.01	0.02	<0.01	4.67
Fm02	167.43	1.30	1.46	0.11	0.87
110	405.95	3.15	22.17	1.73	5.46
111	83.81	0.65	1.46	0.11	1.75
Subtotal - MSdw	680.12	5.28	25.14	1.96	3.70
ESSFdk1					
Fm02	0.81	0.01	0.00	0.00	0.00
110	368.03	2.86	42.25	3.29	11.48
111	35.60	0.28	0.03	<0.01	0.09
Subtotal – ESSFdk1	404.44	3.14	42.28	3.30	10.45
ESSFdkw					
110	53.20	0.41	10.97	0.86	20.62
111	0.00	0.00	0.00	0.00	0.00
Subtotal - ESSFdkw	53.20	0.41	10.97	0.86	20.62
Total	1,137.77	8.83	78.39	6.11	6.89

Note:
1. Description of map units provided in Table 13.5-15 . There are no riparian habitat ecosystems located in the ESSFdkp.

Table 13.5-15: Structural and Compositional Details of Riparian Ecosystems Found in the Landscapes and Ecosystems LSA

Ecosystem Name	Class	Structure and Composition[1]	Landscapes and Ecosystems LSA		Project Footprint	
			Area (ha)	% of Total Area	Area (ha)	% of Total Area
Flood Association – Fringe	Ff	High soil moisture and modified climates produce tall broadleaf shrub or low treed ecosystems that are distinct from the adjacent upland. These ecosystems are differentiated from the Brushland Class in dry environments by tall shrub physiognomy and moist site conditions. Characteristic tall shrubs (i.e., Structural Stages 3a, 3b) are willows, roses (Rosa spp.), water birch (Betula occidentalis), and snowberry (Symphoricarpos albus var. albus). Stunted aspen trees (<10m) can also occur (i.e., Structural Stage 4).	0.75	0.01%	0.00	0.00%
Low Bench Flood	Fl	Low bench ecosystems occur on sites that are flooded for moderate periods (20–40 days) during the growing season. The longer duration of flooding limits the canopy to tall shrubs (i.e., Structural Stages 3a and 3b), especially willows and alders. Fl was mapped where detailed species composition was not available.	17.18	0.13%	0.00	0.00%
Low Bench Flood (Mountain alder – common horsetail)	Fl01	Common throughout the B.C. Interior at elevations below 1,500 m, on gravel or sand bars adjacent to relatively high-gradient creeks and streams that can have "flashy" flood regimes. Dominant species are mountain alder (Alnus incana; i.e., Structural Stages 3a and 3b) and horsetails. Bluejoint reedgrass (Calamagrostis canadensis), oak fern (Gymnocarpium dryopteris), lady fern (Athyrium filix-femina), and western meadowrue often occur.	4.62	0.04%	0.02	<0.01%
Low Bench-Flood (Sitka willow – Red-osier dog-wood – Horsetail)	Fl04	Occurs on levees and sand or gravel bars in the active floodplains of sluggish, low-gradient streams. Sitka willow is the dominant shrub (i.e., Structural Stages 3a and 3b), often occurring with red-osier dogwood (Cornus sericea) and black twinberry (Lonicera involucrate var. involucrata), along with mountain alder, Drummond's willow (Salix drummondiana), and Pacific willow (Salix lucida). Herb cover typically dominated by horsetails and bluejoint reedgrass; however, recent flooding and resulting sedimentation may have limited herb cover.	0.37	<0.01%	0.02	<0.01%

Ecosystem Name	Class	Structure and Composition[1]	Landscapes and Ecosystems LSA		Project Footprint	
			Area (ha)	% of Total Area	Area (ha)	% of Total Area
Middle Bench Flood (Cottonwood – Spruce – Red-osier dogwood)	Fm02	The most common middle bench community of low elevations throughout the Interior on suitable sites. Vegetation overstory (i.e., Structural Stages 4, 5, 6 and 7) dominated by black cottonwood (Populus balsamifera) with minor hybrid white spruce (Picea x glauca) components. The shrub layer is dominated by red-osier dogwood, often with mountain alder, black gooseberry, highbush-cranberry (Vibrunum edule), and occasionally willow and snowberry. Horsetails, sweet-cicely (Myrrhis odorata), and pink wintergreen (Pyrola asarifolia) are common.	168.24	1.31%	1.46	0.11%
Sxw(e)Bl – Azalea (Grouseberry) – Bunchberry (Foamflower)	110	Forested ecosystems (i.e., Structural Stages 4, 5, 6 and 7) occurring on toe and lower slope positions in moist sites with seasonal seepage or subirrigation. Overstory canopy is often dominated by hybrid or Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa). Where present in lower positions (e.g., MSdw), shrubs include black gooseberry (Ribes lacustre), thimbleberry (Rubus parviflorus), false azalea (Menziesia ferruginea), and/or black twinberry (Lonicera involucrata). The understory is often characterized by valerian (Valerian sitchensis and/or V. dioica), arrow-leaved groundsel (Senecio triangularis), meadowrues (Thalictrum spp.), and mitreworts (Mitella spp.).	827.19	6.42%	75.39	5.88%
Sxw(e)Bl – Horsetail - Bluejoint	111	Forested ecosystems (i.e., Structural Stages 4, 5, 6, and 7) on gentle to level receiving sites with the water table typically near the surface or within the top 30 cm of the soil profile. The overstory is typically dominated by hybrid or Engelmann spruce. Where present in lower elevation positions, shrubs may include Red-osier dogwood, black twinberry, and highbush-cranberry. Minor cover of willows (Salix spp.) is also common. Understories are diverse but most often include horsetails (Equisetum spp.) and bluejoint reedgrass (Calamagrostis canadensis).	119.42	0.93%	1.50	0.12%

Note:
1. Summarized from MacKillop et al. (2018).

Riparian habitats occasionally contain invasive plant species in the Landscapes and Ecosystems LSA. Invasive species within riparian ecosystems in the Landscapes and Ecosystems LSA are almost entirely restricted to roadsides. Invasive species observed in the Landscapes and Ecosystems LSA include common sow-thistle (Sonchus arvensis), scentless chamomile (Tripleurospermum inodorum), common tansy (Tanacetum vulgare), hawkweed (Hieracium spp.), and yellow toadflax (Linaria vulgaris). Riparian sites with noted invasive species presence were located at intersections between roads and riparian areas. The most frequently encountered species was yellow hawkweed, followed by annual sow-thistle and scentless chamomile. The highest density of invasive species was found along the middle extent of the Alexander Creek Road.

13.5.2.2.5 Old Growth and Mature Forest

Patch size distributions within the Landscapes and Ecosystems LSA are summarized in Table 13.5-16 along with the relevant targets for patch size distribution as suggested in the Biodiversity Guidebook (Province of B.C., 1995). Old growth and mature forests cover 5,231 ha or 41% of the Landscapes and Ecosystems LSA and 917 ha or 71% of the Project footprint, as outlined in Table 13.5-17 and depicted in Figure 13.5-5.

For areas of old growth and mature forest in the ESSF (both subzones) in the Landscapes and Ecosystems LSA, patches greater than 40 ha in area are within the recommended range of extents; however, patches less than 40 ha in area are below the recommended range of extent. Conversely for the the MSdw in the Landscapes and Ecosystems LSA, patches less than 80 ha were below the recommended extent in the Landscapes and Ecosystems LSA; patches greater than 80 ha exceeded the recommended extent.The extent of old growth forest is below target levels for the MSdw in all Landscape Units designated under the KBLUP that overlap with the Landscapes and Ecosystems LSA, and below target for the ESSFdkw in the East Elk Landscape Unit (Table 13.5-18); all other areas of ESSF in the overlapping Landscape Units contain extents of old growth forest greater than target levels. Conversely, the extent of old growth and mature forest combined is above minimum target areas for all Landscape and BGC Unit combinations, with the exception of the MSdw in the Alexander Line (C20) Landscape Unit.

No legal Old Growth Management Areas (OGMAs) are within the Project footprint. Within the vicinity of the Project, non-legal OGMAs occur locally and regionally and cover approximately 482 ha of the Landscapes and Ecosystems LSA and 249 ha of the Project footprint (Figure 13.5-5). Tree species composition that is expected to occur in old growth and mature forests in the Landscapes and Ecosystems LSA are described by BGC unit in Table 13.5-19.

Table 13.5-16: Actual and Recommended Patch Size Distribution from Biodiversity Guidebook Table (Province of B.C., 1995)

BGC Unit	Patch Size	Recommended % forest area within landscape	Actual % in Landscapes and Ecosystems	In Range?
ESSFdk1, ESSFdkw	<40	10-20	7	Below
	40-250	10-20	18	Within
	>250	60-80	75	Within
MSdw	<40	20-30	10	Below
	40-80	25-40	13	Below
	>80	30-50	78	Above

Table 13.5-17: Composition and Extent of Old Growth and Mature Forest in the Landscapes and Ecosystems LSA

BGC Unit	Composition[1]	Landscapes and Ecosystems LSA				Project Footprint				Proportion of Old + Mature Area Lost (%)
		Mature Area (ha)	Old[2] Area (ha)	Old + Mature Area (ha)	Old + Mature Area (% of LSA)	Mature Area (ha)	Old[2] Area (ha)	Old + Mature Area (ha)	Old + Mature Area (% of Project Footprint)	
MSdw	Overstory composition dominated by Douglas-fir, lodgepole pine, and/or interior spruce, with components of subalpine fir and western larch. Species compositions vary between MSdw site series.	1,945.56	106.23	2,051.8	15.92%	111.27	10.75	122.02	9.51	5.95
ESSFdk1	Overstory composition dominated by Engelmann spruce and subalpine fir, with components of Douglas fir and lodgepole pine. Species compositions vary between ESSFdk1 site series. Douglas-fir dominates the overstory in site series 102, and lodgepole pine in 103.	1,696.43	756.11	2,452.55	19.03%	229.52	207.01	436.54	34.02	17.80
ESSFdkw	Overstory composition dominated by Engelmann spruce and subalpine fir. Species compositions vary between ESSFdkw site series. Subalpine larch contributes to the overstory in site series 102. Whitebark pine is present in small amounts in site series 102 and 103.	233.27	493.5	726.77	5.64%	29.19	329.22	358.41	27.94	49.32
	Total	3,875.26	1,355.84	5,231.12	40.60%	369.98	546.98	916.97	71.47	17.53%

Notes:
1. Summarized from A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia, The East Kootenay (MacKillop et al., 2018). 2. Old Forest age >140 years old.

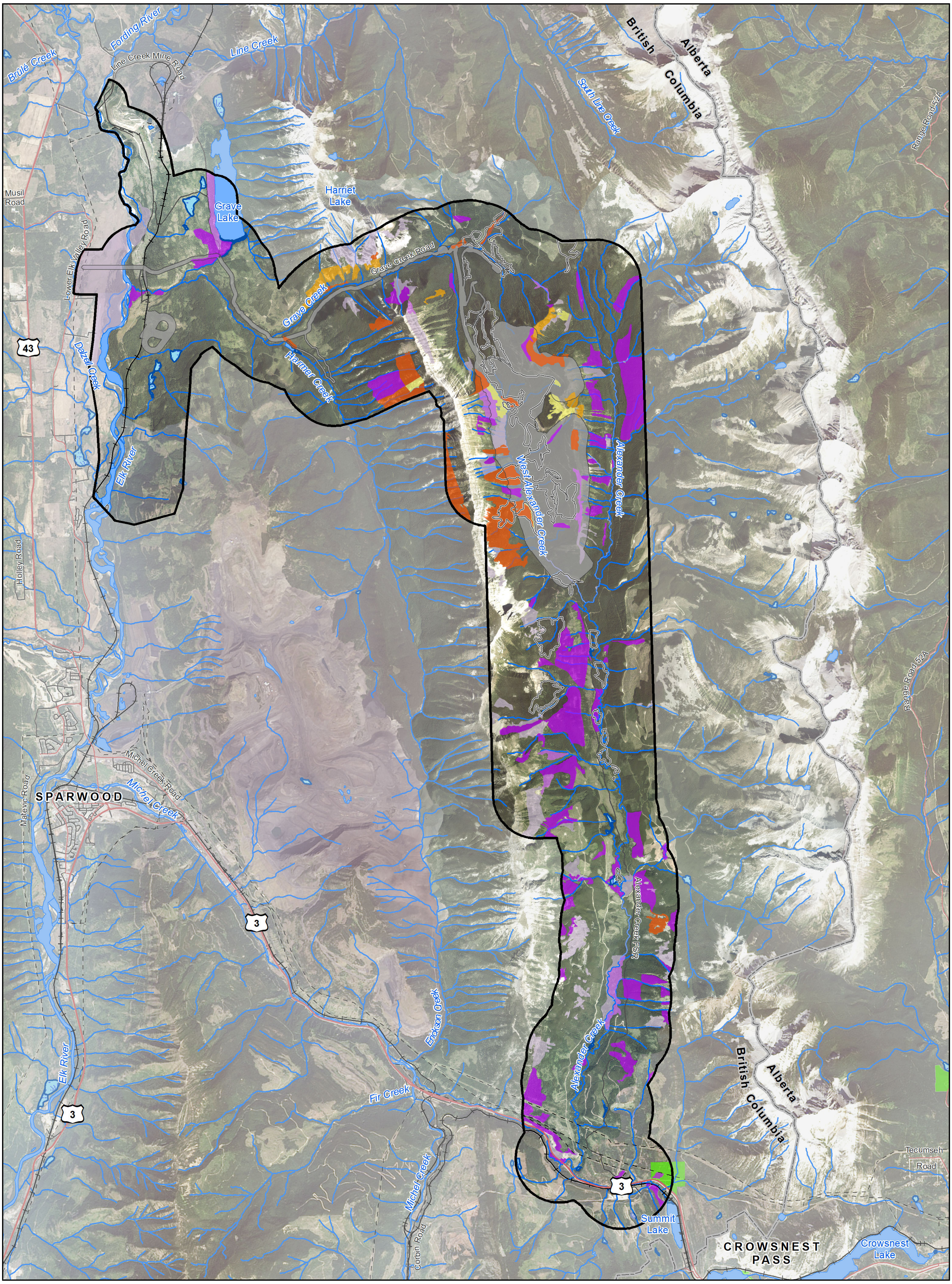

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Figure 13.5-5
Old Growth and Mature Forest in the Landscapes and Ecosystems Local Study Area

Old Growth Management Area (Non-Legal)

Mature Forest (Structural Stage
Mature Forest
Mature Forest (Codominant)
Mature Forest (Subdominant)

Old Forest (Structural Stage
Old Forest
Old Forest
Old Forest

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Table 13.5-18: Amount of Old Growth and Mature Forest for Landscape Units and Biogeoclimatic Unit Intersected by the Landscapes and Ecosystems LSA

Landscape Unit	Biodiversity Emphasis Option	BGC Unit	Total Forested Land Base (FLB; ha)	Old Growth Forest[1]				Old Growth and Mature Forest[1]			
				Minimum Target Area (% of FLB)	Calculated Target Area (ha)	Actual Area in FLB (ha)	Deviation from Target Area (ha)	Minimum Target Area (% of FLB)	Calculated Target Area (ha)	Actual Area in FLB (ha)	Deviation from Target Area (ha)
Corbin Creek (C19)	Low	MSdw	7,650	4.7%	355	202	-153	14%	1,058	1,395	337
Alexander-Line (C20)	Intermediate	ESSFdk1	10,560	14%	1478	1,916	438	23%	2,429	3,185	756
		ESSFdkw	3,998	14%	560	741	181	23%	920	1,584	664
		MSdw	4,198	14%	588	220	-368	26%	1,091	871	-220
West Elk (C23)	Intermediate	MSdw	7,422	14%	1,039	457	-582	26%	1,930	2,104	174
East Elk (C38)	Low	ESSFdk1	4,648	4.7%	218	951	733	14%	651	2,093	1,442
		ESSFdkw	516	4.7%	24	0	-24	14%	72	255	183
		MSdw[2]	N/A	4.7%	N/A	N/A	N/A	14%	N/A	N/A	N/A

Notes:
[1] All data are from the EV-CEMF (Holmes et al., 2018). Only those BGC units present in the Landscapes and Ecosystems LSA are shown.
[2] Data is Not Available (N/A) from Holmes et al. (2018).

Table 13.5-19: Structural and Compositional Details of Old Growth and Mature Forest Ecosystems Found in the Landscapes and Ecosystems LSA

BGC Unit	Structure and Composition[1]	Old and Mature Area (ha)
MSdw	Overstory composition dominated by Douglas-fir, lodgepole pine, and/or interior spruce, with components of subalpine fir and western larch. Species compositions vary between MSdw site series.	2,646
ESSFdk1	Overstory composition dominated by Engelmann spruce and subalpine fir, with components of Douglas fir and lodgepole pine. Species compositions vary between ESSFdk1 site series. Douglas-fir dominates the overstory in site series 102, and lodgepole pine in 103.	3,023
ESSFdkw	Overstory composition dominated by Engelmann spruce and subalpine fir. Species compositions vary between ESSFdkw site series. Subalpine larch contributes to the overstory in site series 102. Whitebark pine is present in small amounts in site series 102 and 103.	877

Note:
[1] Summarized from A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia, The East Kootenay (MacKillop et al., 2018).

13.5.2.2.6 Wetland Ecosystems

Terrestrial Ecosystem Mapping

The TEM identified wetlands within the MSdw, ESSFdk1, and the ESSFdkw units. No wetlands were identified in the ESSFdkp.

Wetlands of the MSdw Unit

The MSdw subzone is located at low to mid-elevations from valley bottom to the Engelmann Spruce-Subalpine Fir zone (about 1,600 m asl). The MSdw is characterised by dry, cool winters and dry, warm summers and autumns. Winter snowpacks are moderately deep and frequently persist from late November through March (MacKillop et al., 2018). The MSdw is the largest and lowest elevation BGC unit, covering 47% of the Landscapes and Ecosystems LSA. A summary of the wetland types identified in the MSdw unit is provided in Table 13.5-3.

Wetlands cover approximately 2% (116 ha) of the MSdw in the Landscapes and Ecosystems LSA (Table 13.5-20) and are considered rare components of this subzone. The TEM study mapped 116 ha of wetlands, including 66 ha of swamp, 31 ha of fen, 15 ha of marsh, and 4 ha of shallow open water wetland within the MSdw unit. Unspecified fens made up the greatest area of fen at 17 ha, followed by the graminoid fen (Wf01) at 8 ha and two shrubby fens (Wf02 and Wf04) at 2 ha and 4 ha, respectively. Most of the area designated marsh (15.3 ha) was Wm01 (13 ha), with small areas of unspecified marsh (1 ha), great bulrush marsh (1 ha), and cattail marsh (0.3 ha). The 66 ha of swamp was made up of unspecified swamp (31 ha), followed by forested swamp, Ws07 at 19 ha, and shrubby swamps Ws04 (9 ha) and Ws03 (7 ha). Unspecified shallow open water wetland was mapped at 4 ha.

Table 13.5-20: Wetlands Identified in the TEM MSdw Unit

TEM Map Unit	Ecosystem Name	Mapped Area (ha)	% of MSdw
Wf	Wetland - Fens	17	0.28
Wf01	Water sedge – Beaked sedge Fen	8	0.13
Wf02	Scrub birch – Water sedge Fen	2	0.03
Wf04	Barclay's willow – Water sedge – Glow moss Fen	4	0.07
Wm	Wetland - Marsh	1	0.02
Wm01	Beaked sedge – Water sedge Marsh	13	0.21
Wm05	Cattail Marsh	0.3	0.00
Wm06	Great bulrush Marsh	1	0.02
Ws	Wetland - Swamp	31	0.51
Ws03	Bebb's willow – Bluejoint Swamp	7	0.12
Ws04	Drummond's willow – Beaked sedge Swamp	9	0.15
Ws07	Spruce – Horsetail – Leafy moss Swamp	19	0.31
Ww	Shallow water	4	0.07
	Total	116	1.92

The Project TEM (Appendix 13-A) notes that the alkaline/saline meadow class, Ga03$, and low bench floodplain associations (FL01 and FL04) occur, but does not consider them in a wetland context. Ga03$ covers 2 ha and 0.03% of the MSdw. Two low bench floodplain associations are mapped. Fl01 is assigned the largest area at 5 ha and 0.08% of the MSdw. Fl04 is assigned 0.4 ha, which is 0.01% of the MSdw. Floodplain associations, which are riparian ecosystems, occur along creeks and waterbodies Landscape and Ecosystems LSA and in some cases are associated with wetland ecosystems.

Wetlands of the ESSFdk1 Unit

Above the Montane Spruce zone is the Engelmann Spruce-Subalpine Fir (ESSF) zone, which is the uppermost forested zone in the interior of B.C. (Coupé et al., 1991). Moist summers and cold winters with heavy snowfall characterize the zone's climate. The Elk Dry Cool Engelmann Spruce-Subalpine Fir (ESSFdk1) covers 37% of the Landscapes and Ecosystems LSA, with wetlands covering less than 0.1% of the ESSFdk1 unit.

The TEM identified 4 ha of wetland in the ESSFdk1, including 2 ha of unspecified fen (Wf), 1 ha of graminoid marsh (Wm01), and 1 ha of unspecified swamp (Ws) (Table 13.5-21).

Table 13.5-21: Wetlands Identified in the TEM ESSFdk1 Unit

TEM Map Unit	Ecosystem Name	Mapped Area (ha)	% of Subzone
Wf	Wetland – Fens	2	0.04
Wm01	Beaked sedge – Water sedge Marsh	1	0.03
Ws	Wetland – Swamp	1	0.02
	Total	4	0.09

Wetlands of the ESSFdkw

The Dry Cool Woodland Engelmann Spruce-Subalpine Fir (ESSFdkw) subzone occurs above the Elk Dry Cool variant (ESSFdk1) at elevations between about 1,900 m asl and 2,200 m asl. It is like the ESSFdk1, but due to its higher elevation, it is generally characterized by shorter growing seasons and lower productivity. The ESSFdkw covers 12% of the Landscapes and Ecosystems LSA, with wetlands identified as covering 2 ha or 1% of the ESSFdkw. Two (2) ha of alpine wetland (Wa) was the only wetland area found in the ESSFdkw. Other wetlands near the Project footprint and within the Terrestrial LSA may be affected indirectly by Project activities. These wetlands are discussed in the following section.

Wetland Ecosystems Baseline Assessment

Surveyed wetland ecosystems account for 0.16% or 39.23 ha of the Terrestrial LSA and 0.05% or 0.69 ha of the Project footprint (Table 13.5-22). Six wetland classes are represented in the wetlands surveyed in the Terrestrial LSA and include bog, fen, marsh, swamp, shallow open water, and a transitional/successional marsh-fen (Table 13.5-22; Appendix 13-B). Three non-wetland groups, two transition mineral associations, and a flood association were also recorded within the Terrestrial LSA due to their close association with wetlands and account for 0.0062% or 1.52 ha of the Terrestrial LSA. Marsh constitutes the largest area of all wetlands surveyed and of non-wetland groups surveyed at 13.88 ha, followed by swamp at 13.43 ha, transitional marsh-fen at 5.39 ha, shallow open water at 3.73 ha, fen at 2.76 ha, transitional mineral association at 0.92 ha, and bog at 0.04 ha. Flood associations constitute 0.60 ha of the Terrestrial LSA. Most wetlands surveyed ranged in size from 0.01 to 0.25 ha (n=11) and 0.51 to 0.75 ha (n=10) (Appendix 13-B). Four surveyed wetlands occur within the Project footprint: WL7; WL8.1; WL8.2; and WL8.3; while 32 surveyed wetlands occur adjacent to or outside the Project footprint in the Terrestrial LSA (Table 13.5-23; Figure 13.5-6).

In the Terrestrial LSA, wetlands were generally restricted to flat areas, valleys, and bowls and many formed in basins, depressions, and through obstructions such as beaver dams along drainage ways. Basin wetlands are fed by creeks, surface drainage, and drainage from the adjacent slope. Layers of peat of various depths and stages of decomposition develop and sustain marsh (thin peat layer) and fen (deep peat layer) communities. Many of the wetlands observed form wetland complexes of two or more distinct wetland associations. Wetlands surveyed varied in size, with some variation attributable to wetland delineation and composition. Adjoining wetland site associations that differed markedly in structure and species composition, such as a graminoid fen and treed swamp, were considered separately, as were those separated by markedly different features and those with distinctive physical or topographical features. Marsh and shallow water commonly occurred together, but some larger wetland complexes comprised additional wetlands such as bog, fen, swamp, and transitional mineral terrestrial units. The boundary between each unit is usually a gradual, transitional area with characteristics of each that is not considered when assigning areas to each unit. Where these areas are broad, a semi-arbitrary division is established based on plant species composition, structure, and landform.

Table 13.5-22: Wetland Ecosystems Documented within the Terrestrial LSA and Project Footprint

BGC Unit	Provincial Wetland Classification	Ecosystem Name	Structural Stage	Terrestrial LSA Extent (ha)	Terrestrial LSA Extent (%)	Project Footprint Extent (ha)	Project Footprint Extent (%)
MSdw	Wb15	Spruce - Labrador tea - Peat moss	3a (low shrub) [5 young forest]	0.04	0.0002	-	-
	Wf01	Water sedge - Beaked sedge	2b (graminoid-dominated)	2.17	0.0090	-	-
	Wf02	Scrub birch - Water sedge	3a (low shrub) [2b graminoid dominated]	0.59	0.0024	-	-
	Wm01	Beaked sedge - Water sedge	2b (graminoid-dominated)	9.66	0.0399	-	-
	Wm04	Common spike-rush herbaceous vegetation marsh	2b (graminoid-dominated)	0.01	0.0000	-	-
	Wm05	Cattail	2b (graminoid-dominated)	0.39	0.0016	-	-
	Wm06	Great bulrush	2b (graminoid-dominated)	1.67	0.0069	-	-
	Wm07	Baltic Rush Marsh	2b (graminoid-dominated)	0.55	0.0023	-	-
	Wm15	Bluejoint - Beaked sedge	2b (graminoid-dominated)	0.40	0.0017	-	-
	Wm01-Wf01	Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	2b (graminoid-dominated)	5.39	0.0222	-	-
	Ws03	Bebb's willow – Bluejoint	3b (tall shrub)	0.62	0.0026	-	-
	Ws04	Drummond's willow – Beaked sedge	3b (tall shrub)	2.00	0.0083	-	-
	Ws05 (probable)	MacCalla's willow – Serviceberry willow - Beaked sedge	3b (tall shrub)	6.00	0.0248	-	-
	Ws07.1	Spruce - Horsetail - Leafy moss	6 (mature forest)	0.59	0.0024	-	-

BGC Unit	Provincial Wetland Classification	Ecosystem Name	Structural Stage	Terrestrial LSA Extent (ha)	Terrestrial LSA Extent (%)	Project Footprint Extent (ha)	Project Footprint Extent (%)
	Ws07.2	Spruce - Horsetail - Leafy moss	6 (mature forest)	3.46	0.0143	-	-
	Ww unspecified	Shallow Water	2c (aquatic)	0.91	0.0038	-	-
	Ww Muskgrass	Muskgrass shallow water	2c (aquatic)	1.22	0.0050	-	-
	Ww Pondweed	Pondweed shallow water	2c (aquatic)	0.12	0.0005	-	-
	Ww White Water-Buttercup	White water-buttercup	2c (aquatic)	0.03	0.0001	-	-
	Ww Yellow Pond-Lily Type	Yellow pond-lily - Bladderwort shallow water	2c (aquatic)	0.10	0.0004	-	-
ESSFdk1	Wm01	Beaked sedge - Water sedge	2b (graminoid-dominated)	1.08	0.0045	0.15	0.0117
	Wm16	Bluejoint - Arrow-leaved groundsel	2b (graminoid-dominated) / 2a (forb-dominated)	0.04	0.0002	0.04	0.0031
	Ws04 (probable)	Drummond's willow - beaked sedge Swamp	3b (tall shrub)	0.20	0.0008	-	-
	Ws07.1	Spruce - Horsetail - Leafy moss	6 (mature forest)	0.56	0.0023	-	-
	Ww unspecified	Shallow Water	2c (aquatic)	1.35	0.0056	0.42	0.0327
ESSFdkw	Wm01	Beaked sedge - Water sedge	2b (graminoid-dominated)	0.08	0.0003	0.08	0.0062
			Total	39.23	0.16	0.69	0.05

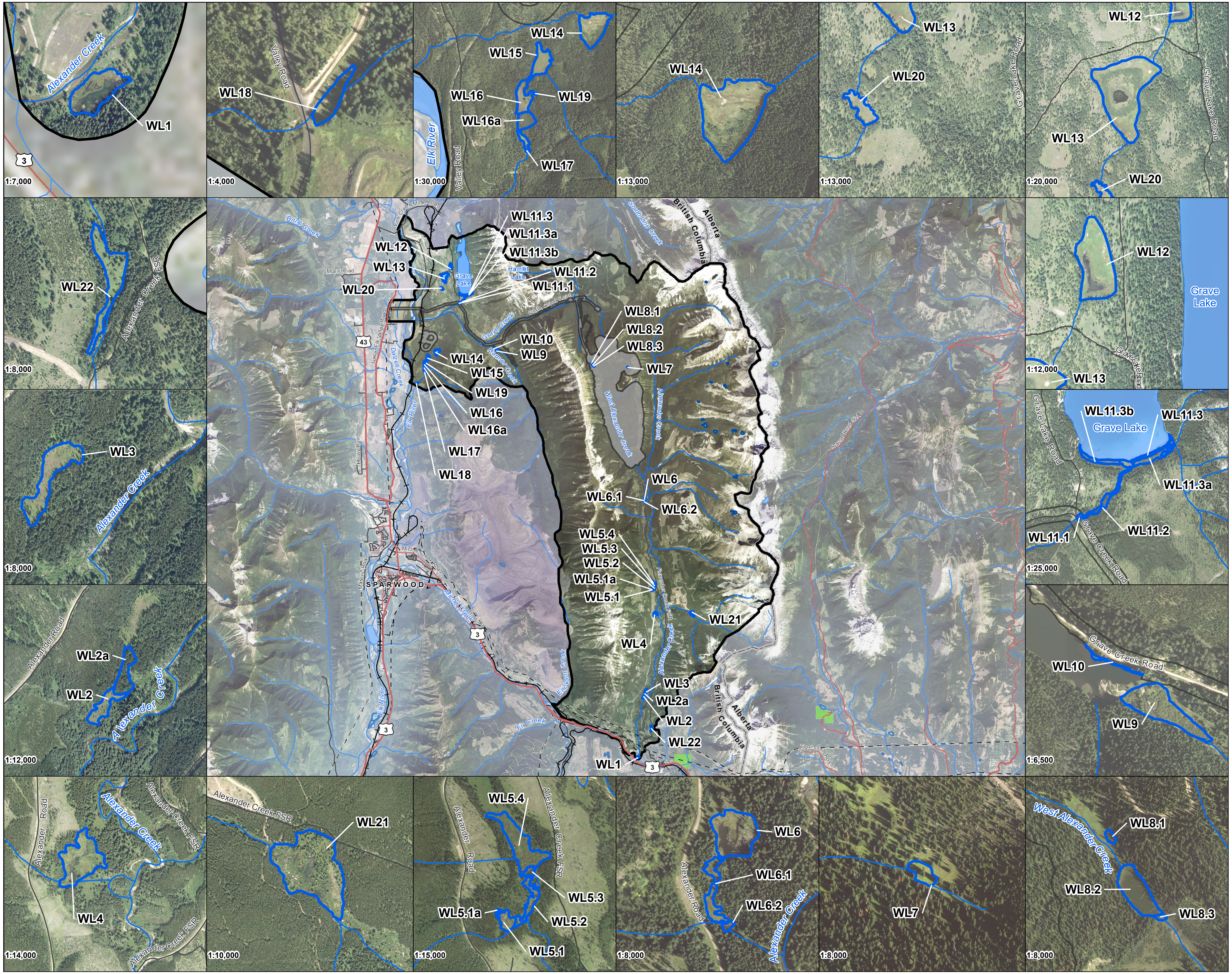
Table 13.5-23: Proximity of Wetland Ecosystems to the Project Footprint

Wetland Survey Site ID	Proximity to Project Footprint (m) *	Wetland Survey Site ID	Approximate Proximity to Project Footprint (m)*
WL7	0.00	WL13	953
WL8.2	0.00	WL18	1,517
WL8.1	0.00	WL6	1,538
WL8.3	0.00	WL12	1,568
WL11.1	1.00	WL6.1	1,602
WL10	6.00	WL6.2	1,706
WL9	20.50	WL5.4	5,412
WL11.2	61.96	WL5.3	5,656
WL15	153.08	WL5.2	5,696
WL14	184.47	WL5.1a	5,805
WL11.3b	332.75	WL5.1	5,808
WL11.3	417.40	WL4	6,897
WL16	445.76	WL21	7,374
WL11.3a	467.93	WL3	10,520
WL19	557.47	WL2a	10,691
WL20	651.42	WL2	10,817
WL16a	712.80	WL22	12,249
WL17	863.85	WL1	13,678

Note: * Proximity of wetland to Project footprint is based on the distance from surveyed wetland edge to edge of the Project footprint (i.e., closest edge to closest edge).

The Wm01 Beaked sedge – Water sedge marsh was the most common wetland site association observed and covered 10.82 ha of the Terrestrial LSA. Marsh was most often recorded along the edges of shallow water wetlands, but also occurred in basins, along drainage channels, and at the edge of open water. Bogs and fens of the Terrestrial LSA occur in basins and adjacent to shallow water wetlands. The transitional/successional wetland association Wm01-Wf01 represents wetlands in which marsh (Wm01) and fen (Wf02) were found together, suggesting communities where marsh is succeeding to fen as organic matter (sedge peat) gradually accumulates. Within the Project footprint, an unspecified shallow water wetland (Ww) and Wm01 were the most common, with these ecosystems documented at 2 and 3 wetlands, respectively.

The transitional mineral associations Ga02$ and Ga03$ represent disturbed seral alkaline meadow communities that experience early season inundation and late season drying, which concentrates salts (MacKillop et al., 2018). Flood groups occur in dynamic complexes along channels and shallow water, and in some areas can be difficult to distinguish from swamp wetland associations. The only documented occurrence of the marsh site association Wm16 Bluejoint-Arrow-leaved groundsel in the Terrestrial LSA was at WL8.1. WL7 is present in a small, gently sloping area of a steep slope surrounded by wet meadows of herbaceous vegetation, small, meandering streams, and nearby patches of mature subalpine fir.



Crown Mountain Coking Coal Project

Figure 13.5-6
Wetland Ecosystems in the Terrestrial Local Study Area

LEGEND

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

0 2.5 5
Kilometres

Scale 1:175,000

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: LMM/PR
Map Checked By: LKD
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

Project: 12-6231
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File Location: \\42dillon\CAD\GIS\2012 and Prior\126231 Crown Mountain\EA_Report\ExistingConditions\Terrestrial\126231_EC_TEwl_WetlandEcosystemsLSA.mxd

The precise composition of grass-like plants at WL7 was not confirmed due to the timing of the survey (i.e., early in the season) and access constraints (i.e., roadwork). The vegetation and landscape position of WL7, including its presence among a herbaceous wet meadows, distinguishes it from other marshes surveyed in the Project footprint and Terrestrial LSA.

Wetland Catchments

Wetland catchment areas are the upslope areas that drain water into a wetland. Wetland catchments within the Terrestrial LSA are drainage subunits of, and occur within, the greater drainage areas identified as the Alexander Creek, Elk River, Grave Creek, and Harmer Creek watersheds (Appendix 13-B; Chapter 10). Wetland catchment areas range in size across the Terrestrial LSA and occurred across small, lower elevation areas (e.g., site WL1) to larger areas at mid-elevation. The Alexander Creek watershed contained the highest number of wetlands surveyed (n=19), followed by the Elk River watershed (n=10), Grave Creek watershed (n=5), and the Harmer Creek watershed (n= 2).

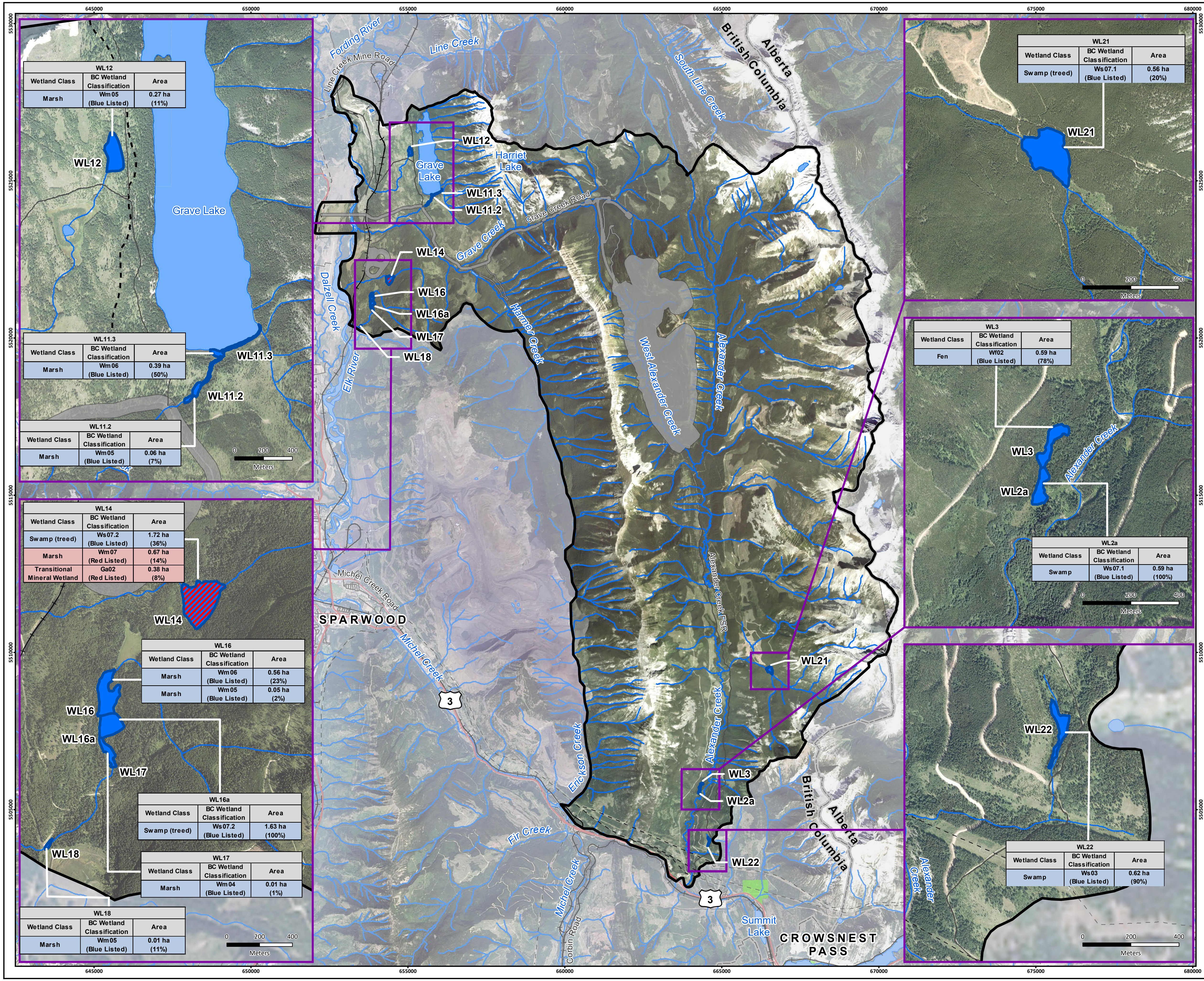
Wetlands within the Project footprint occur in the Alexander Creek watershed and represent two small catchment areas. Wetlands WL8.1, WL8.2, and WL8.3 occur along a drainage basin and are closely tied to one another ecologically and occur in the headwaters of West Alexander Creek. WL8.1 is an ephemeral marsh that dries up after snow melt and subsequently fills and evaporates with rainfall during the growing season. No surveyed wetlands in the Alexander Creek watershed, beyond those within the Project footprint, are sustained by flows from Alexander Creek; rather, they are fed by small tributaries of Alexander Creek.

Listed and Rare Wetland Plants and Ecosystems

The wetland baseline study identified 11 wetland site associations and 3 non-wetland site associations in the Terrestrial LSA listed by the B.C. CDC as special concern (Blue-listed) and at risk of being lost (Red-listed) (Table 13.5-24; Table 13.5-25; Table-13.5-26). No species at risk were identified in wetland ecosystems as part of the wetland ecosystem baseline assessment. Several wetlands in the northwestern portion of the Terrestrial LSA were found to contain site associations currently ranked by the B.C. CDC, many of which are marshes. No Red- or Blue-listed wetland site associations were found to overlap with the Project footprint and no SARA-listed wetland plant species or communities were found within the Terrestrial LSA or Project footprint.

One Red-listed site association, Wm07, was observed in the Terrestrial LSA at WL14 and 10 Blue-listed site associations were observed across 14 wetlands in the Terrestrial LSA (Figure 13.5-7). The Red-listed Wm07 was found to occur in the same wetland complex in which two Red-listed non-wetland alkaline-saline meadows were observed, Ga02$ and Ga03$. WL14 is the northernmost wetland complex in a series of wetlands in a drainage basin that extends southward to WL17 and contains other units of conservation.

The Blue-listed wetland moss, Scorpidium cossonii, was observed at wetland survey site WL3 and formed a larger component of the surveyed wetland. A small, thallose liverwort (Moerckia flotoviana) was also recorded in WL3. It is not listed by the B.C. CDC but is known only from a few records in British Columbia. The moss Drepanocladus longifolius, present in abundance in WL11.1 and also found in WL16, is Yellow-listed (least risk of being lost) but known from few collections in B.C. At wetland WL7, a small marsh on a seepage slope is surrounded by an extensive wet, herbaceous meadow classified as Wm01 based on the presence of water sedge and highly decomposed peat; however, wetland WL7 supports meadow



Crown Mountain Coking Coal Project

Figure 13.5-7
Wetlands with Listed and Rare Plant Communities

LEGEND

- Surveyed Wetland Ecosystem
- Red and Blue-Listed Site Associations
- Blue-Listed Site Association
- Terrestrial Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Provincial Park/Protected Area
- British Columbia/Alberta Border

0 2.5 5
Kilometres

Scale 1:115,000

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: PR
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Map Coordinate System: NAD 1983 UTM Zone 11N

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Table 13.5-24: Provincial Conservation Status Ranking of Wetland Ecosystems

BGC Unit	Provincial Wetland Classification*	Ecosystem Name	Provincial Listing	Provincial Status	Structural Stage	Wetland Observations	Terrestrial LSA Extent (ha)	Terrestrial LSA Extent (%)
MSdw	Wf02	Scrub birch - Water sedge fen	Blue	S3	Low shrub / Graminoid	WL3	0.59	0.0024
	Wm04	Common spike-rush herbaceous vegetation marsh	Blue	S3	Graminoid	WL17	0.01	0.0000
	Wm05	Cattail marsh	Blue	S3	Graminoid	WL11.2; WL12; WL16; WL18 (anthropogenic)	0.39	0.0016
	Wm06	Great bulrush marsh	Blue	S3	Graminoid	WL11.3; WL11.3b; WL16	1.67	0.0069
	Wm07	Baltic Rush Marsh	Red	S2	Graminoid	WL14	0.55	0.0023
	Ws03	Bebb's willow - Bluejoint swamp	Blue	S3	Tall shrub	WL22	0.62	0.0026
	Ws04	Drummond's willow – Beaked sedge swamp	Blue	SNR	Tall shrub	WL17	2.00	0.0083
	Ws07.1	Spruce - Horsetail - Leafy moss swamp	Blue	S3	Mature forest	WL2a	0.59	0.0024
	Ws07.2	Spruce - Horsetail - Leafy moss swamp	Blue	S3	Mature forest	WL14; WL16a	3.46	0.0143
ESSFdk1	Ws04 (probable)	Drummond's willow - beaked sedge swamp	Blue	S2S3	Tall shrub	WL21	0.20	0.0008
	Ws07.1	Spruce - Horsetail - Leafy moss swamp	Blue	S3	Mature forest	WL21	0.56	0.0023
						Total	10.64	0.04

Note: * Probable represents the closest site association match possible to the floristic assemblages presented in MacKenzie and Moran (2004) and MacKillop et al. (2018).

Table 13.5-25: Provincial Conservation Status Ranking of Non-Wetland Group Ecosystems

BGC Unit	Provincial Wetland Classification*	Ecosystem Name	Provincial Listing	Provincial Status	Structural Stage	Wetland Observations	Terrestrial LSA Extent (ha)	Terrestrial LSA Extent (%)
MSdw	Ga02$ (probable)	Nuttall's alkaligrass – Foxtail barley Alkaline/saline meadow (probable)	Red	S2	Graminoid	WL14	0.38	0.0016
	Ga03$	Field Sedge (Seral) Alkaline/saline meadow	Red	S1S2	Graminoid	WL14	0.54	0.0022
ESSFdk1	Fl05 (probable)	Drummond's willow – Bluejoint reedgrass flood Association	Blue	Unknown	Tall shrub	WL21	0.20	0.0008
						Total	1.12	0.01

Note: * Probable represents the closest site association match possible to the floristic assemblages presented in MacKenzie and Moran (2004) and MacKillop et al. (2018).

Table 13.5-26: Provincial Conservation Status Ranks

Rank	B.C. CDC Definition	NatureServe Subnational Conservation Ranks
Red-listed	Ecological communities, native species, and subspecies in B.C. that are at the greatest risk of being lost (extirpated, endangered, or threatened).	Plants: SX, SH, S1, S1S2, S2, S2?, S1S3 Ecological Communities: SX, SH, S1, S1S2, S2
Blue-listed	Ecological communities, native species, and subspecies in B.C. that are of special concern.	Plants and Ecological Communities: S2S3, S2S4, S3, S3?
Yellow-listed	Ecological communities and native species in B.C. that are at the least risk of being lost.	Plants and Ecological Communities: S3S4, S3S5, S4, S4S5, S5
Special Concern	Particularly sensitive to human activities or natural events but not endangered or threatened.	-

herbaceous species uncharacteristic of Wm01. This particular expression of Wm01 is unique among marshes in the Terrestrial LSA, but is not recognized as a separate site association or variant by the B.C. CDC.

Invasive Plants

Invasive, non-native plants were common around wetlands that occur near roads and clearings and in areas isolated from roads and clearings where the invasives were likely transported by wildlife and wind. At all wetlands, invasive species were restricted to mineral soils not inundated for prolonged periods (Table 13.5-27). For most wetlands, invasive plants occupied peripheral areas transitional to surrounding uplands. The distribution and abundance of invasive plant species suggested populations were maintained by periodic or frequent soil disturbance by animals such as beaver, deer, elk, and cattle. Canada thistle (Cirsium arvense) and perennial sow-thistle (Sonchus arvensis) were dominant on beaver dams and in small clearings beside wetlands near roads.

In most wetlands, invasive plant species were restricted to peripheral areas where they had no apparent adverse effects on wetland ecology. The distribution of invasive plants could change if the volume of water received and the frequency and duration of flooding changes. No invasive, introduced aquatic plants were observed during the wetland ecosystem surveys. Canada thistle, observed at sites WL4, WL5.2, WL10, WL15, and WL 17 is considered noxious provincially (ISCBC, 2019). Perennial sow-thistle, observed at sites WL4, WL15, and WL17, is also provincially noxious (ISCBC, 2014). Noxious weeds are non-native species considered “highly destructive, competitive and difficult to control” (ISCBC, 2014). No invasive plant species were observed in wetlands within the Project footprint; however, some wetlands (e.g., WL9 and WL10) occur adjacent to roadways within the Project footprint and were found to contain several invasive plants.

Special coding has been developed to classify wetlands that are predominantly composed of invasive species (MacKillop et al., 2018); however, none of the major species for which the codes are developed were found in the Terrestrial LSA and none of the invasive non-native species observed in the wetlands occurred in greater abundance than native species. The non-native invasive species found in the Terrestrial LSA were not strictly aquatic plants; that is, they were not species that occur only or primarily in wetland conditions.

Table 13.5-27: Non-native (Introduced) Plants Observed at Wetland Ecosystems

Wetland Site ID	Documented Non-native Species	Characteristics of Invasive Species
WL4	Canada thistle, perennial sow-thistle, hemp-nettle, common dandelion	Invasive plants abundant along southwest edge and adjacent field
WL5.2	Canada thistle	Observed on small patch of mineral soil
WL9	Timothy, oxeye daisy, common dandelion	Invasive plants restricted to shoreline
WL10	Canada thistle	Invasive plants restricted to shoreline
WL14	English plantain, foxtail barley	Invasive plants restricted to a terrestrial mineral grassland association adjacent to wetland

Wetland Site ID	Documented Non-native Species	Characteristics of Invasive Species
WL15	Canada thistle, perennial sow-thistle	Invasive plants observed at north end of wetland in drier area
WL17	Canada thistle, perennial sow-thistle	Invasive plants very abundant on some beaver dams and small clearings

Wetland Functional Assessment

For the purposes of the discussion of results, the functional capacity of only those wetlands that have the potential to be adversely affected by the proposed Project is presented. A total of four wetlands occur within the Project footprint, WL7, WL8.1, WL8.2 and WL8.3, which have the potential to be directly affected by Project development. The capacity of a wetland to perform certain functions is related to site-specific factors that vary between wetland classes. Key functional capacities, those rated as moderate to high, of wetlands WL7, WL8.1, WL8.2, and WL8.3 are provided in Table 13.5-28. Additional detail of the results of the wetland functions assessment is provided in Appendix 13-D.

Wetland WL7 is a small marsh in a near-flat area of an extensive herbaceous meadow on a steep avalanche path. The functional capacity of WL7 is variable due in part to its small size, plant species composition, deep, humic peat, and its position in a topographically flat area near the toe of a steep slope and avalanche path. Although classified as Wm01 (Beaked sedge - Water sedge marsh), based on the predominance of water sedge, other plants typical of the surrounding herbaceous meadows were also present, creating a plant community not observed elsewhere in Terrestrial LSA. The thick peat underlying the wetland suggests a fen, but its composition, uniformly fine and humic (von Post 7-8), confirms marsh, and on that basis, that label was applied. WL7 is the highest surveyed wetland at 2,089 m asl and the only wetland surveyed in the ESSFdkw.

Wetlands WL8.1, WL8.2, and WL8.3 are located along the same watercourse in a small drainage basin at the source of West Alexander Creek. WL8.1 is a small, ephemeral marsh in the lower slope of a large meadow that drains into the shallow water wetland, WL8.2. Wetland WL8.1 wetland is filled periodically during rainfall events during the growing season. The small size and potential water storage volumes of WL8.1 limit the overall functional capacity of the wetland in the landscape (low-moderate); however, the functional capacity of the wetland, particularly for hydrological, biochemical, and the provision of habitat for plants with high habitat specificity, could be moderate to high. The presence of an Olive-sided Flycatcher (Contopus cooperi; Blue-listed and listed as Threatened on Schedule 1 of SARA) during breeding season in trees at the edge the meadow clearing emphasizes the importance of vegetation surrounding wetlands.

WL8.2 is a large shallow water wetland in a depression between steep slopes at the headwaters of West Alexander Creek. The functional capacity of WL8.2 is low to moderate. The landscape position, shaded and sheltered at base of steep slopes, altitude, and basin topography with a lack of shallows, likely limit many wetland functions and reduce the potential for biomass production. The high storage volume may increase functional capacity for some biochemical functions, especially with input of sedimentation.

WL8.3 is a small sedge marsh at the outflow and south end of WL8.2 comprising a predominance of beaked sedge. The deposition of organic matter (peat layer) is substantial (20 cm). The functional capacity of WL8.2 is estimated to be low to moderate with a tendency towards moderate because, despite its small

Table 13.5-28: Key Wetland Functions of Wetlands within the Project Footprint

Wetland Site ID	Wetland Function	Capacity to Perform Function	Description
WL7	Water quality treatment	Moderate-high	Considerable potential to filter and remove particulates and nutrients
	Nutrient transformation (cycling)	Moderate-high	Large biomass and fluctuating soil moisture (oxidation)
	Nutrient and organic matter export	Moderate	Low flows (mostly groundwater), dense vegetation, and thick peat suggest downslope nutrient transport but little organic matter export
	Carbon sequestration and storage	High	Small area but significant (fen-like) peat accumulation
	Sediment and particulate retention (i.e., prevent downstream movement)	Moderate	Reduced velocity and vegetative obstruction
	Native plant species richness	Moderate	Water sedge interspersed with meadow herbs
	Rare/uncommon native community	Moderate-high	Community encountered nowhere else in the Terrestrial LSA
WL8.1	Groundwater recharge	Moderate	Hydrological conductivity of underlying soils presumed moderate, but limited area of influence
	Amphibians	Moderate	Wetland contribute early season and periodic living habitat and food downstream
WL8.2	Waterflow moderation/reduction in peak flows (flood protection)	Moderate	Large area and storage volume but constrained by steep slopes
	Surface water detention	Moderate	Large area and storage volume but constrained by steep slopes
	Climate (local) regulation	Moderate	Evaporation from the large surface will affect temperature
	Water quality treatment	Moderate	High potential based on water volume storage moderated by low biomass and possibly, low temperatures
	Sediment and particulate retention (i.e., prevent downstream movement)	Moderate-high	Large storage volume and long potential storage time
	Nutrient removal (phosphorus)	Moderate	Few plants for uptake but moderate potential related to sedimentation
	Invertebrates	Moderate	Presumed moderate from landscape position and temperature
	Fish	Moderate-high	Has the potential to support fish based on connectivity to West Alexander Creek
	Amphibians	Moderate-high	Western toad observed along shoreline near outflow; temperature and productivity may be prohibitive to other species

Wetland Site ID	Wetland Function	Capacity to Perform Function	Description
WL8.3	Shoreline stabilization/erosion reduction	Moderate	Dense sedge reduces outlet erosion
	Water quality treatment	Moderate	Considerable potential to filter and remove particulates and nutrients
	Sediment and particulate retention (i.e., prevent downstream movement)	Moderate	Reduced velocity and vegetative obstruction
	Amphibians	Moderate	Provides good potential forage and cover habitat (the western toad attributed to WL8.2 was found near WL8.3

size, it appears to be efficient at performing multiple functions. WL8.3 filters organic matter, nutrients, contaminants, and sediment, and reduces WL8.2 outflow water velocity. It lacks plant diversity and has limited habitat potential for animals, although it may be used for forage and cover by the western toad observed nearby.

Other wetlands in the Terrestrial LSA may experience indirect (non-physical disturbance) effects arising from the Project. For example, some wetlands outside the Project footprint may not experience loss or physical disturbance, but may be indirectly affected by dust deposition, introduction of invasive species, hydrological changes due to infiltration of water into Project excavations (e.g., open pits), or other indirect effects. The extent of those changes is difficult to predict in advance in this Application/EIS, and therefore they will be subjected to adaptive management as required, should follow-up and monitoring demonstrate changes to the function of those wetlands.

13.6 Project Effects Assessment

13.6.1 Thresholds for Determining Significance of Residual Effects

The evaluation of the measurement indicators of each VC when carrying out the Project effects assessment considers the rationale for the selection of the landscapes and ecosystems VCs. In all cases, VCs were chosen primarily due their functions as habitat for wildlife (NWP Coal Canada Ltd, 2016). Different portions of a VC may not have equal value as habitat (e.g., differing values of old growth compared to mature forest; differing values of herb, shrub, or tree dominated avalanche chutes). Project effects on these more valuable portions of the VC need to be emphasized (e.g., emphasize effects to old growth forests, emphasize effects to herb dominated avalanche chutes).

13.6.1.1 Avalanche Chutes

There are no known defined thresholds, benchmarks, or other scientific or regulatory requirements explicitly and inherently applicable to avalanche chutes. Alternatively, other projects of similar context for which an Environmental Assessment Certificate has been issued may inform such thresholds by way of established precedent.

Specifically, Teck Coal Limited (Teck; Teck; 2015) attributed a loss of 13 ha of avalanche chute ecosystems for the proposed Baldy Ridge Expansion Project, which comprised 5.2% of the avalanche chute ecosystems in the respective local study area. Although Teck did not provide a quantifiable threshold, the residual effect was proposed to be “not significant”, for which the British Columbia EAO did not identify any disagreement (EAO, 2016).

In its application for the Line Creek Operations Phase II Expansion Project (the Line Creek Project), Teck (2011) defined the magnitude of residual effects as negligible (i.e., <1% change from baseline conditions), low (i.e., 1% - 10% change from baseline conditions), moderate (i.e., 10% - 20% change from baseline conditions), and high (i.e., >20% change from baseline conditions). Teck (2011) predicted irreversible net loss of 65 ha, or 44.2% of the high alpine grassland/herb ecosystems due to the Line Creek Project; however, an assessment of the residual effect under the application case was not provided. Alternatively, the residual effect was assessed in the context of regional, cumulative effects, for which the cumulative loss of high alpine grassland/herb ecosystems was estimated to be 15% in the respective regional study area, and therefore found to be of moderate magnitude and not significant. That said, the Line Creek Project's residual effects to high alpine grassland/herb ecosystems amounted to less than 5% of the total area affected in the respective regional study area. Similar to that provided for the Baldy Ridge Expansion Project, the EAO (2013) did not identify any disagreement with the conclusions regarding impacts to high alpine grassland/herb ecosystems.

In consideration of the precedents established for projects of similar size and context (i.e., Teck, 2011 and Teck, 2015), the magnitude of a residual effect to avalanche chute ecosystems is defined as the remaining area affected following all Post-Closure ecological restoration that is:

- Negligible: less than or equal to 1% of the total VC area within the Landscapes and Ecosystems LSA under the Baseline Case;
- Low: greater than 1% and less than or equal to 5% of the total VC area within the Landscapes and Ecosystems LSA under the Baseline Case;
- Moderate: greater than 5% and less than or equal to 25% of the total VC area within the Landscapes and Ecosystems LSA under the Baseline Case; and
- High: greater than 25% of the total VC area within the Landscapes and Ecosystems LSA under the Baseline Case.

A significant adverse residual effect is defined as one where the Project affects more than 25% of avalanche chute ecosystems within the Landscapes and Ecosystems LSA (i.e., high magnitude) that is not reversible (i.e., permanent duration) within the timeframe of the Post-Closure phase following implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3).

13.6.1.2 Grasslands

Grasslands are important ecosystems, which provide habitat for a variety of wildlife and plant species, including provincially and federally listed species-at-risk. Occurrences of listed and rare plant species found in the Landscapes and Ecosystems LSA, detailed in Table 13.5-12, were identified most often in grassland ecosystems.

A significant adverse residual effect on grassland ecosystems is defined as a Project-caused effect that:

- Results in the loss of grassland ecosystems of an extent that poses a risk to the long-term viability and persistence of grassland ecosystems in the Landscapes and Ecosystems RSA, against which avoidance, mitigation, or restoration measures cannot be feasibly applied; and
- Results in the direct mortality of an individual listed plant species or ecological community such that the likelihood for long-term survival of the listed plant population or ecological community in the East Kootenay is reduced as a result.

There are no quantitative threshold values or guidelines related to grasslands or provincially-listed ecological communities or species currently available in B.C. As such, the above-listed thresholds have been selected as the thresholds for determining significance of residual effects on grassland ecosystems. None of the listed plant communities and species documented within the Landscapes and Ecosystems LSA are currently listed under the SARA (2002) or designated as at-risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

13.6.1.3 Riparian Habitat

Davidson et al. (2018) characterizes benchmarks of disturbance to riparian habitat within the EV-CEMF in three levels:

- Low: <10% riparian disturbance;
- Moderate: >10% but < 20% riparian disturbance; and
- High: ≥20% riparian disturbance.

Davidson et al. (2018) calculated this indicator of riparian impacts based on the linear length of disturbed/removed riparian habitat per unit length stream length within each defined Assessment Watershed. Given that the Project TEM (Appendix 13-A) provides riparian habitat mapped as two-dimensional polygons (rather than linear line segments of riparian habitat along watercourses), potential impacts to riparian habitats were quantified as the proportion of total riparian habitat removed relative to the total area of riparian habitat in the Landscapes and Ecosystems LSA.

In consideration of the above, a significant adverse residual effect on riparian habitats is defined as one where the Project directly results in the removal of more than 20% of riparian habitat within the Landscapes and Ecosystems LSA (i.e., high magnitude) that is not reversible (i.e., permanent duration) within the timeframe of the Post-Closure phase following implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3). In circumstances where the magnitude of potential changes to riparian habitats cannot be accurately quantified (i.e., not directly attributable to assessed VCs), then the quantification of potential change of an intermediate VC (e.g., alteration of surface water quantity) was considered.

13.6.1.4 Old Growth and Mature Forest

Old growth and mature forest abundance and distribution may be quantified using the extent of old growth and mature forests in the Landscapes and Ecosystems LSA and the Project footprint. Minimum target areas of old growth and mature forest are provided under the Kootenay Boundary Higher Level Plan Order (KBHLPO), which are further refined according to BGC and Landscape Units within the EV-CEMF.

Landscape and BGC units are characterized by Holmes et al. (2018) according to a “hazard rating” for old growth forest, whereby existing conditions are rated relative to the range of natural variation under pre-settlement conditions. Where existing conditions closely match the range of natural variation, they are assigned a hazard rating of “Very Low”. Conversely, where the existing extent of old growth and mature forests deviates strongly from the range of natural variation, the landscape unit is assigned a hazard rating of “Very High”. In consideration of the target areas identified under the KBHLPO, together with the implications of loss in areas already highly impacted by human activity, a significant effect on the abundance and distribution of old growth and mature forests is defined as:

- A reduction in the area of old growth or old growth and mature forests (combined) to below the specified target in a BGC and Landscape Unit of any hazard rating; or
- A further reduction in the area of old growth or old growth and mature forests (combined), where already below the specified target in a BGC and Landscape Unit of Medium, High or Very High hazard rating.

For those parameters that are not attributable to established thresholds, a significant adverse residual effect was defined as a high magnitude, irreversible change from baseline condition across any frequency of occurrence. The following limits were used for defining the magnitude of a residual effect on old growth and mature forest where thresholds are not previously defined:

- Negligible: No detectable changes from baseline conditions (i.e., <1% change);
- Low: 1% - 5% change;
- Moderate: 6% - 15% change; and
- High: >15% change.

13.6.1.5 Wetland Ecosystems

A significant adverse residual effect on wetland ecosystems is defined as a Project-caused effect that results in a net loss of wetland function that cannot be avoided, mitigated, or compensated in accordance with objectives of the Federal Policy on Wetland Conservation (Government of Canada, 1991).

Although the Federal Policy on Wetland Conservation is applicable only to federal lands, the potential impact to wetland ecosystems on private and Crown land as a result of development projects is important to consider. Wetlands provide habitat for a variety of terrestrial and aquatic species, including several sensitive and/or listed species, such as western toad, and can be used by a variety of carnivore and ungulate species for foraging. Given the importance of wetland ecosystems both provincially and federally, the Federal Policy on Wetland Conservation goal for "no net loss" of wetland functions has been selected as the threshold for determining significance of residual effects to wetland ecosystems.

13.6.2 Project Interactions

Project activities and components have the potential to result in adverse effects to landscapes and ecosystems and cause landscape disturbance. This assessment focuses only on planned activities within the designed scope of the Project. Effects related to unplanned events (e.g., spills, equipment malfunctions, accidents) are presented in Chapter 21.

Project activities during the Construction and Pre-Production, Operations, Reclamation and Closure, and Post-Closure phases have the potential to affect landscapes and ecosystems, but most effects will occur during the Construction and Pre-Production phase due to clearing and tree removal to make way for Project facilities within the Project footprint. Key Project activities that are expected to interact with landscapes and ecosystems, with a potential for adverse effects, are presented in Table 13.6-1. Specific details on Project activities and components are discussed in Chapter 3.

The assessment of Project effects is predicated on a worst-case scenario, such that the Project impact on the VC in question is assumed to occur 100% throughout the Project footprint, which includes a buffer to allow for the contingency in the event that the Project design is altered. In other words, to assure a conservative assessment, it is assumed that 100% of the amount of a particular VC (i.e., avalanche chutes, grasslands, riparian habitat, old growth and mature forests, and wetlands ecosystems) that is present within the Project footprint is lost in order to make way for the development of the Project, and it is further assumed that this loss (though sometimes reversible over the long-term) continues until reclamation activities are undertaken during the Reclamation and Closure phase. This affords a conservative assessment of the effects of the Project on landscapes and ecosystems. The Project effects identified for each landscapes and ecosystems VC are discussed in the following subsections.

Table 13.6-1: Project - Landscapes and Ecosystems VCs Interaction Matrix and Ranking

Project Phase	Project Component	Description of Activities	Valued Component				
			Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forest	Wetland Ecosystems
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	I	III	II	II	II
	Logging of Merchantable Timber	Merchantable timber will be logged from the infrastructure and pre-production development footprint	I	I	III	III	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	III	III	III	III
	Stockpiling Wood Waste	Wood waste will be stockpiled on site and used for reclamation as a source of coarse woody debris	I	I	I	I	I
	Quarry for Construction Materials	Excavation of road bed materials from the North Pit footprint for use on Grave Creek Road	I	I	II	I	I
	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	I	I	II	I	I
		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	I	I	II	II	I
		Grave Creek Reservoir will be constructed to act as a back-up source of process water	I	I	II	II	I

Project Phase	Project Component	Description of Activities	Valued Component				
			Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forest	Wetland Ecosystems
	Soil Salvage	Soil will be salvaged from the footprint of the infrastructure	II	II	II	I	II
	Road Upgrading and Construction	Branch C Road will be widened and upgraded to facilitate construction and mine traffic to plant site area	I	I	II	II	I
		Grave Creek Road will be widened to facilitate the clean coal haul	I	I	II	II	II
		A new road will be constructed off the Valley Road to access the rail loadout for construction and operation	I	III	I	II	I
	Linear Infrastructure	Installation of the powerline	I	I	III	III	II
		Installation of the natural gas line	I	I	III	III	II
	Overland Conveyor	Clearing, grubbing, and construction of overland conveyor from the plant site to Grave Creek Road	I	I	I	I	I
	Coal Handling Process Plant Construction	Excavating and pouring of foundation	I	I	I	I	I
		Transportation of materials and personnel to site	I	I	I	I	II
		Constructing of the Coal Handling Process Plant (CHPP)	I	I	I	I	I
		Commissioning of the CHPP	I	I	I	I	I
	Workshop / Mine Dry Construction	Excavating and pouring of foundations	I	I	I	I	I
		Transportation of materials to site	I	I	I	I	II
		Construction of workshop / mine dry	I	I	I	I	I
		Equipment wash bay and heavy equipment parking	I	I	I	I	I
		Administration, first aid and mine dry building	I	I	I	I	I
		Diesel tank farm	I	I	I	I	I

Project Phase	Project Component	Description of Activities	Valued Component				
			Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forest	Wetland Ecosystems
		Warehouse	I	I	I	I	I
		Potable water system	I	I	I	I	I
		Septic system	I	I	I	I	I
		Water supply pipelines from Grave Creek and West Alexander Creek	I	I	I	I	I
		Commissioning of the facilities	I	I	I	I	I
	Rail Loadout Construction	Excavation and preparation of the rail bed	I	III	II	I	II
		Excavation and preparation of foundation stockpiling and coal handling systems	I	I	I	I	I
		Transportation of materials and personnel to site	I	I	I	I	II
		Construction of rail loadout	I	III	II	I	II
		Connection to the CP Fording Sub-line	I	I	I	I	I
		Commissioning of the rail loadout	I	I	I	I	I
	Labour	Hiring of personnel for the mine, CHPP operations administration, and coal haul	I	I	I	I	I
		Training of personnel	I	I	I	I	I
	Construction Waste Materials	Collection and transfer to a recycling facility or other approved facility	I	I	I	I	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	I	II	II	II	II

Project Phase	Project Component	Description of Activities	Valued Component				
			Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forest	Wetland Ecosystems
	Explosives Factory	Ammonium nitrate / emulsion storage facilities which have the ability to load explosive agents into delivery trucks	I	I	I	I	I
		Wash facility to decontaminate the bulk explosive delivery trucks	I	I	I	I	I
		Storage of explosives (detonators and boosters)	I	I	I	I	I
	Fuel Storage	Receiving bulk fuel deliveries	I	I	I	I	I
		On-site storage of fuel	I	I	I	I	I
		Dispensing fuel	I	I	I	I	I
		Transferring fuel to on-site delivery trucks	I	I	I	I	I
	Mine Roads Development	Building roads from material sourced on-site	I	I	I	I	I
	Mining	Progressive clearing	III	I	II	III	I
		Removal of unconsolidated material	III	I	II	I	I
		Loading, hauling, and stockpiling of soil	II	II	II	I	I
		Drilling and loading of blastholes	I	I	I	I	I
		Detonating the explosives	III	I	I	II	I
		Loading, hauling and dumping of mine rock	II	I	II	I	I
		Loading, hauling and stockpiling of coal	II	I	I	II	I
	Site Water Requirements	Using contact water as the primary process make-up water from Interim Sediment Pond (Year 1 to 5)	I	I	I	I	I
		Using contact water as the primary process make-up water from the North Pit (Year 5 to 15)	I	I	I	I	I

Project Phase	Project Component	Description of Activities	Valued Component				
			Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forest	Wetland Ecosystems
		Backup reservoir in Grave Creek as a secondary source of process make-up water	I	I	II	I	I
	Coal Processing	Run of mine coal sizing	I	I	I	I	I
		Washing coal	I	I	I	I	I
		Mechanical and thermal drying of coal	I	I	I	I	I
		Coal reject disposal (part of loading, hauling, and dumping of mine rock activities)	I	I	I	I	I
		Conveying clean coal	I	I	I	I	I
	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	I	I	I	I
	Main Sediment Pond	Construction of Main Sediment Pond in Year 4	I	I	III	I	I
		Management of the Main Sediment Pond discharge	I	I	III	I	I
	Reclamation	Reclaiming available areas as soon as possible to achieve reclamation objectives	I	I	I	II	I
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	I	I	I	I	I
	Dismantling Infrastructure and Buildings	Dismantling of the CHPP, maintenance facilities, administration, and other facilities	I	I	I	I	II
		Dismantling, salvaging, collecting, and transferring materials to a recycling facility or other approved facility	I	I	I	I	II

Project Phase	Project Component	Description of Activities	Valued Component				
			Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forest	Wetland Ecosystems
	Removal of Linear Infrastructure	Removal of the powerline	I	I	I	I	II
		Removal of the natural gas line	I	I	I	I	II
	Reclamation	Reclaiming available areas as soon as possible to achieve reclamation objectives	II	II	II	II	I
	Monitoring	Reclamation monitoring	I	I	I	I	I
		Geotechnical monitoring	I	I	I	I	I
		Aquatic effects monitoring	I	I	I	I	I
	Water Management	Management of the Main Sediment Pond discharge	I	I	II	I	I
Post-Closure	Water Management	Decommissioning the Main Sediment Pond once water quality objectives have been met	I	I	II	I	I
	Road Use	Branch C Road will remain as a permanent access road for future commercial and recreational use	I	I	II	II	I
	Rail Line	The rail line will remain as a permanent feature	I	II	I	I	I
	Monitoring	Reclamation monitoring	I	I	I	I	I
		Geotechnical monitoring	I	I	I	I	I
		Aquatic effects monitoring	I	I	I	I	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

13.6.3 Project Effects on Avalanche Chutes

13.6.3.1 Discussion of Potential Effects

Avalanche chutes are assessed through two measurement indicators: ecosystem abundance and distribution, and compositional and structural changes.

Without mitigation, the Project has the potential to affect avalanche chute ecosystems in the Landscapes and Ecosystems LSA through physical removal, altering disturbance regimes, introducing invasive plant species, and increasing fugitive dust. Potential effects on avalanche chutes due to the Project that are carried forward in the discussion of potential effects are identified in Table 13.6-2 and discussed in the context of each Project phase below.

Table 13.6-2: Potential Effect on Avalanche Chutes

Potential Effect	Rationale for Selection of Environmental Effect
Change in Abundance and Distribution of Avalanche Chutes	Where overlapping with the Project footprint, logging, clearing, and grubbing of vegetation, and removal of soil and overburden will necessarily remove areas of avalanche chutes within the Project footprint that will reduce the abundance and alter the distribution of avalanche chutes. Additionally, complete removal of avalanche start zones may stabilize the disturbance regime, causing the successional trajectory of downslope avalanche chutes to change so substantially such that the baseline ecosystem is complete lost.
Change in Composition and Structure of Avalanche Chutes	Deposited sediments and airborne deleterious substances can disrupt plant physiological processes (e.g., evapotranspiration) and may change the albedo of the adjacent winter snow, potentially increasing the rate of snowmelt, which may be substantial enough to alter the soil moisture regime, conferring a competitive advantage for species that favour drier conditions. Incomplete removal of avalanche start zones may alter the disturbance regime sufficiently to favour a shift to increased woody species that are more tolerant of reduced frequency and/or reduced severity of avalanche disturbance. Additionally, changes in the acoustic environment caused by blasting during the Operations phase can alter the disturbance regime of retained avalanche chutes within the Landscapes and Ecosystems LSA. Finally, where vehicles and/or equipment arrive to the Project with soil and/or vegetation debris, or such vehicles and/or equipment must contact or be operated in the vicinity of existing occurrences, the Project may cause the introduction and/or spread of non-native and invasive species that may outcompete and alter the composition of avalanche chute ecosystems.

13.6.3.1.1 Change in Abundance and Distribution of Avalanche Chutes

Construction and Pre-Production

Potential effects on the abundance and distribution of avalanche chutes are anticipated in the Construction and Pre-Production phase of Project development, predominantly associated with the clearing and grubbing of vegetation, as well as stockpiling of soil, required to access and excavate the overburden from the North Pit area that will be used for the improvement of the Grave Creek Road and construction of other Project infrastructure (e.g., access roads, workspaces). This area may overlap with avalanche chute ecosystems.

Operations

Potential effects on the abundance and distribution of avalanche chutes are anticipated in the Operations phase of Project development. Specifically, lateral expansion of the pits will require incremental loss of avalanche chute ecosystems as mining activities expand further south. Although mining activities and associated surface disturbance shall be restricted to areas of surface accessible coal, additional backsloping may be required to manage surrounding geohazards or to otherwise facilitate safe access to and efficient extraction of the resource. This may extend into the start zones for avalanche chutes located downslope from the Project, particularly north and east of the mine pit areas. Where the mine pits overlap with avalanche chutes, including those areas that act as start zones to avalanche chutes further downslope, there is potential for loss of abundance and distribution of avalanche chute ecosystems.

Reclamation and Closure

Potential effects on the abundance and distribution of avalanche chutes are not anticipated in the Reclamation and Closure phase of the Project. Although reclamation of the Project footprint may include restoration of herbaceous dominant high alpine communities, it is unlikely that the restored terrain contours will be sufficient to generate conditions suitable for the development of avalanche disturbance regimes that maintain the restored ecosystem in a successional stage of disclimax.

Post-Closure

Potential effects on the abundance and distribution of avalanche chutes are not anticipated in the Post-Closure phase of the Project.

13.6.3.1.2 Change in Composition and Structure of Avalanche Chutes

Construction and Pre-Production

Potential effects to the composition and structure of avalanche chutes are anticipated during the Construction and Pre-Production Phase. There is potential for the operation of vehicles and equipment to result in the erosion, suspension, and deposition of dust from exposed soils, construction material (e.g., road fill), coal stockpiles, and mine waste. Additional particulate matter and airborne deleterious substances may be released by the operation of diesel machinery. Where deposited on snow, dust (including particulate matter from combustion engines) can decrease the albedo of the retained snowpack elsewhere in the Landscapes and Ecosystems LSA, increasing the absorption of heat energy, and consequently the rate of snowmelt. During the winter months, increased snowmelt may have variable effects on the frequency and severity of avalanches. Where increased snowmelt consolidates the snowpack over weak layers or surfaces, the severity and/or frequency of avalanche events may increase. Alternatively, increased snowmelt due to reduced albedo from deposited dust may reduce the overall depth of, or increase the overall consolidation of the snowpack, thereby reducing the severity and/or frequency of avalanche events. Where the rate of snowmelt increases due to deposition of dust during the spring and early summer, there is potential for the soil moisture regime to be affected, facilitating incursion by species favouring earlier germination and generally drier conditions. Finally, where deposited directly on vegetation, dust and airborne deleterious substances may disrupt plant physiological processes (e.g., evapotranspiration), causing reduced vigour of existing vegetation. A reduction in plant vigour may result in a loss of vegetation cover or entire species within affected avalanche chutes, increasing susceptibility to erosion and/or incursion of invasive species that typically occupy disturbed or otherwise non-vegetated areas.

As they have evolved outside the context of the local native vegetation communities and typically reproduce or spread at substantially higher rates than local species, non-native or invasive species typically have a competitive advantage over native vegetation. Further, some non-native and invasive species even release chemicals (e.g., knapweeds [Centaurea spp.]) to further restrict the growth of desirable native vegetation. In the event that vehicles and/or equipment arrive to the Project carrying soil or vegetation debris, or where crossing through existing occurrences, operation of vehicles and equipment during the Construction and Pre-Production phase of Project development may introduce and/or spread non-native and invasive species within avalanche chute ecosystems. Further, other potential mechanisms affecting the vigour and competitive ability of desirable vegetation (e.g., dust) may facilitate the introduction and/or spread of non-native and invasive species.

Where the Project footprint overlaps with their respective start zones, avalanche chutes downslope from the Project may experience altered disturbance regimes that otherwise maintain the ecosystems in a successional stage of disclimax. Specifically, removal of the start zones of avalanche chutes reduces the total snowpack catchment area that releases into an avalanche chute; reduced catchment area reduces the volume of snow and therefore reduces the severity and frequency of avalanches (i.e., the disturbance regime). Alteration of the disturbance regime may favour a shift to increased woody species that are more tolerant of reduced frequency and/or reduced severity of avalanche disturbance, including shrubs (in the case of herbaceous meadow avalanche chutes), and/or trees (in the case shrub thicket avalanche chutes). Retained treed avalanche chute ecosystems would likely exhibit a shift in structural stage such that trees grow beyond the pole/sapling stage and may shift towards composition and structural stage conditions of adjacent, undisturbed site associations.

Collectively, these sources of dust, airborne deleterious substances, altered disturbance regimes, and non-native and invasive species have potential to result in alteration of the composition and structure of avalanche chute ecosystems outside of the Project footprint. Although these sources of impact may possibly occur frequently and endure for a prolonged period in some locations, uncertainty in the vegetation response precludes the ability to quantify the extent and magnitude of change in the composition and structure of avalanche chute ecosystems.

Operations

Potential effects to the composition and structure of avalanche chute ecosystems are anticipated during the Operations phase. In addition to the continuation of all potential sources of impact from the Construction and Pre-Production phase, routine avalanche control and unintentional consequences to the acoustic environment during the Operations phase have potential to further alter the composition and structure of avalanche chutes outside the Project footprint. Specifically, routine avalanche control reduces the volume of snow conveyed in targeted avalanche chutes[1] at any given release by decreasing the period

[1] Only those avalanche chutes intersected by the Project footprint and posing a risk to operational safety are likely to be targeted for avalanche control.

of time between releases. Simultaneously, blasting within the mine pit during the Operations phase can cause pressure waves that destabilize the snowpack elsewhere in the Landscapes and Ecosystems LSA, having the same effect. The reduced volume of snow conveyed per avalanche event is likely to reduce the potential for disturbance to the underlying vegetation. Similar to the effect of reduced catchment through elimination of the avalanche start zone, alteration of the disturbance regime due to avalanche control and unintentional consequences of blasting can alter the disturbance regime, and therefore the composition and structure, of avalanche chute ecosystems in the Landscapes and Ecosystems LSA.

Reclamation and Closure

Potential effects on avalanche chute composition and structure are anticipated in the Reclamation and Closure phase. Similar to that exhibited under the Construction and Pre-Production and Operations phases, changes to the composition and structure of avalanche chute ecosystems may be anticipated largely through the effects associated with deposition of dust and snow, both within the Project footprint and elsewhere in the Landscapes and Ecosystems LSA. The release of dust, and its associated effects on the composition and structure of vegetation, will continue until reclamation of the Project footprint is complete.

Post-Closure

Potential effects on the composition and structure of avalanche chutes are not anticipated in the Post-Closure phase of Project development.

13.6.3.1.3 Transboundary Effects

The Project is located approximately 5 km west from the provincial border with Alberta and approximately 85 km north from the international border with the United States and the State of Montana. As discussed in Chapter 1, Section 1.3.3, federal land is not required to facilitate the Project and the Project does not overlap with any federal land. The most frequent wind direction recorded at the Project baseline climate station was from the southeast while the wind data recorded at the Sparwood CS station is predominant northerly and southerly. The atmospheric environment assessment (Chapter 6, Section 6.5.4.2.1) concluded that no measureable transboundary effects on air quality in Alberta, the United States, or on federal lands are anticipated to occur as a result of the Project. As such, no transboundary effects to avalanche chutes as they relate to fugitive dust or changes in air quality are anticipated to occur.

13.6.3.2 Mitigation Measures

The mitigation measures proposed for avalanche chutes are based on available best management practices (BMPs), guidance documents, mitigation measures conducted 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 (B.C MOE, 2014a and B.C. MOE, 2014b).

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

13.6.3.2.1 Mitigation Measures for Change in Abundance and Distribution of Avalanche Chutes

Logging, Clearing, Grubbing and Soil Salvage

Avalanche chutes have the potential to be affected through site clearing and grubbing activities, and the removal of vegetation and soil. Where avoidance of avalanche chutes within the Project footprint is not possible, additional mitigation measures have been provided to minimize the severity, or geographic or temporal extent of the potential effects. Although implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) will restore similar herbaceous and shrub dominated vegetation communities, it is unlikely that reclamation activities will restore disturbance regimes where altered due to the Project footprint.

To mitigate the change in abundance and distribution of avalanche chutes within the Project footprint over the course of the Project, the following mitigation measures will be implemented:

- Minimize disturbance and encroachment into avalanche chutes (including their start zones), to the smallest extent feasible, by clearing and grubbing only what is required for Construction and Pre-Production activities and development of the Project;
- Implement the Soil Management Plan (Chapter 33, Section 33.4.1.9) to salvage and stockpile soils from avalanche chutes removed during the Construction and Pre-Production phase for future reclamation activities;
- Implement the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1) and the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4) to reduce indirect impacts to downwind avalanche chutes; and
- Monitor reclaimed areas to evaluate effectiveness of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) in meeting reclamation goals and objectives.

Information collected as part of follow-up to the management plans (Chapter 33) will be used to inform success of reclamation and compensation strategies and determine, if necessary, the implementation of appropriate adaptive management strategies.

Change in Disturbance Regime

Avalanche chute ecosystems have potential to be affected by reduction of the frequency and/or severity of avalanche events (i.e., the disturbance regime) due to removal of the respective start zones that overlap with the Project footprint during the Construction and Pre-Production and Operations phases of the Project. The only means of mitigating the potential change of disturbance regime affecting the abundance and distribution of avalanche chute ecosystems is to minimize disturbance and encroachment to the smallest extent feasible in the start zones of avalanche chutes to the north and east of the Project's mine pits.

13.6.3.2.2 Mitigation Measures for Change in Composition and Structure of Avalanche Chutes

Erosion, Deposition of Dust, and Release of Deleterious Substances

Construction and operational activities have the potential to erode soils and cause deposition of dust and airborne deleterious substances to avalanche chutes downwind from the Project. Deposited sediments or other airborne deleterious substances may interfere with plant physiological processes that affect the vigour of, and subsequently the diversity and dominance of, desirable, native vegetation. In turn, this increases the susceptibility of avalanche chutes to incursion by non-native and invasive species. The measures provided in the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1), the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4), the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11), the Soil Management Plan (Chapter 33, Section 33.4.1.9) and the Spill Prevention, Control, and Countermeasures Plan (Chapter 33, Section 33.4.1.10) shall be implemented as described therein; the following additional measures shall be included wherever feasible:

- Enforcement of low speed limits for vehicular traffic throughout the site to minimize dust;
- Maintain unpaved roads and keep in good repair, including regular road compaction and use of coarse aggregate with low silt content, where possible;
- Conduct earth moving activities in a manner that reduces exposed soils and avoids dust-generating activities during windy periods, where possible;
- Spray water or other dust suppression methods during dry periods from May to November to mitigate dust generation in areas including unpaved roads and work areas. 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;
- Locate soil stockpiles at appropriate locations far from avalanche chutes, and store and shape in ways to allow for slope stability, including establishment of vegetation to reduce exposure to wind erosion;
- Use progressive reclamation and revegetation throughout the mine life to minimize wind erosion potential and reduce the Project footprint;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to avalanche chutes;
- Monitor and inspect dust control measures are effective and functioning properly, which will allow for timely maintenance and adjustments as required;
- Minimize the extent of disturbance within and adjacent to avalanche chutes to the smallest extent necessary; and
- Conduct regular inspections of control measures established to address erosion and sedimentation and complete necessary repairs in a timely manner to protect avalanche chute ecosystems.

Disturbance Regime

Avalanche chute ecosystems have potential to be affected by reduction of the frequency and/or severity of avalanche events (i.e., the disturbance regime) due to removal of the respective start zones that overlap with the Project footprint, as well as the implementation of avalanche control measures and unintentional consequences of blasting during the Operations phase. Specific mitigation measures to reduce the potential for adverse effects to avalanche chute abundance as a result of changes to the disturbance regime include:

- Minimize disturbance and encroachment to the smallest extent feasible in the start zones of avalanche chutes to the north and east of the Project's mine pits;
- Limit the frequency of use and explosive potential for all explosives used in the Operations phase to the lowest level necessary, including explosives used for avalanche control;
- Reduce the need for the use of explosives in avalanche control by constructing diversion berms and/or retention walls where avalanche chutes are anticipated to runout on to the Project footprint; and
- Schedule blasting in mine pits to occur during periods of relatively high stability in the snowpack, particularly during earlier periods of the winter prior to development of a permanent ground cover of snow, when feasible.

Invasive Plants

All mine construction, operation, and reclamation activities requiring ground disturbance and/or removal of vegetation may result in the introduction or spread of non-native and invasive species. Prior to Construction and Pre-Production, it is anticipated that a Project-specific management plan for invasive plants will be developed as an operational guide to manage invasive plants within the Project footprint and be implemented across the Project footprint over the course of the Project to control existing and future invasive plant populations.

Measures to control existing invasive plant populations and reduce the potential for the introduction of additional invasive plants in Construction and Pre-Production, Operations, and Reclamation and Closure include:

- Identify and demarcate invasive plant populations around avalanche chutes prior to Construction and Pre-Production;
- Establish setback areas and "no-work" areas if invasive plant populations are located near avalanche chutes to reduce the spread of invasive plants by machinery and vehicles;
- Remove existing occurrences of non-native and invasive species near avalanche chutes to prevent the spread to adjacent areas;
- Undertake invasive control activities, including distribution of biocontrol agents, and mechanical and chemical treatments;
- Reduce exposure of bare ground near avalanche chutes ;
- Restore sites with native vegetation species following treatment of invasive infestations and ground disturbance to establish vegetative cover;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to avalanche chutes;
- Restrict vehicle and machinery traffic to designated access roads; and
- Apply contouring and erosion control measures to limit spread of invasive and agronomic species seed and plants.

Additional mitigation measures related to invasive species management are provided in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

13.6.3.2.3 Summary of Mitigation Measures for Avalanche Chutes

The key mitigation measures proposed to mitigate potential effects on avalanche chutes are summarized in Table 13.6-3.

Proposed mitigation measures generally align with standard industry practice, are well understood, and proven to effectively reduce adverse effects on the abundance, distribution, composition, and structure of avalanche chute ecosystems. As it is unlikely that optimization of the Project design and avalanche control can completely avoid all effects to avalanche chute ecosystems, confidence with the effectiveness of mitigation measures is considered low to moderate. Where mitigation measures do not or may not mitigate all effects or if there is a low 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.

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 Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

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

13.6.3.3.1 Assessment Methods

The characterization of residual effects follows methods outlined in Chapter 5, Section 5.3.4.5. Ecosystem-specific methods used in the assessment of residual effects are detailed below.

A footprint analysis was used to determine areas of the Project footprint that overlap and interact with avalanche chutes. The maximum Project footprint extent, including clearing and contingency areas, presents the maximum extent of disturbance associated with the Project (as detailed by “Project footprint” boundary depicted in Figure 13.6-1).

Given the complexity of relationships among species and the abiotic environment, and that not all mechanisms of impact act equally in all locations at all times, characterization of changes in composition and structure was conducted qualitatively in consideration of industry best practices and the professional judgement of the authors.

13.6.3.3.2 Potential Residual Effects Assessment

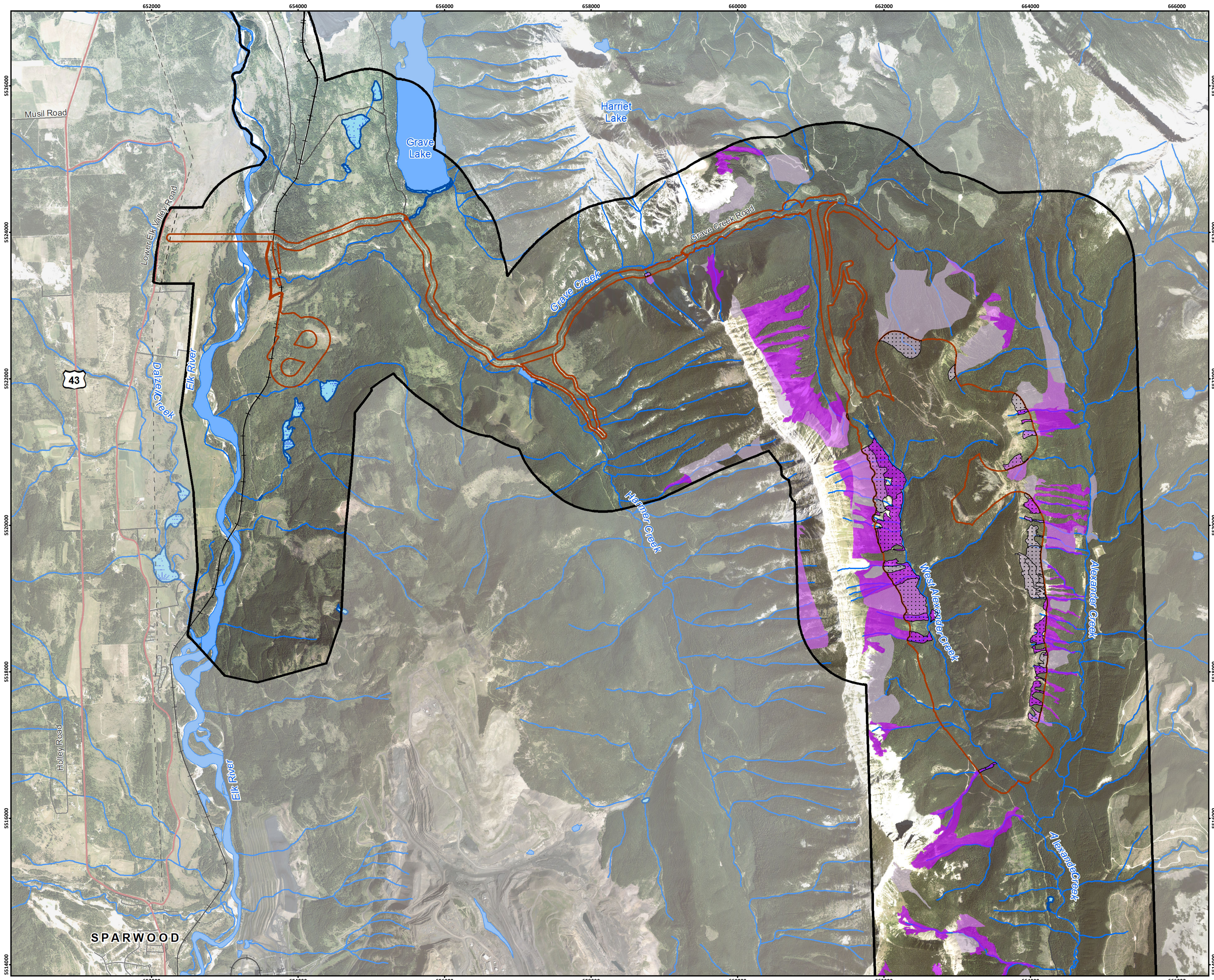
Potential Project-related changes in the abundance and distribution of avalanche chute ecosystems was predicted to occur, both directly from overlap with the Project footprint, and indirectly from changes in disturbance regimes. Where changes in the disturbance regime does not result in their complete loss, the composition and structure of avalanche chute ecosystems may be alternatively affected. With the successful implementation of the recommended mitigation measures, the remaining potential effects on the composition and structure of avalanche chutes from Project activities (i.e., effects of erosion, deposition of dust, and airborne deleterious substances in avalanche chutes, as well as introduction and/or spread of invasive species) were predicted to be completely mitigated such that a residual effect does not occur; those potential effects are not carried further in the assessment and rated not significant with a high level of confidence.

Table 13.6-3: Summary of Proposed Mitigation Measures Related to Avalanche Chutes

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Abundance and Distribution of Avalanche Chutes	• Project design optimization • Implementation of Ecological Restoration Plan • Minimizing disturbance and cleared areas	• Measures contribute to the avoidance, minimization, and restoration of avalanche chute losses associated with construction, mining, and operational management activities. • Effects of Project development on the abundance and distribution of avalanche chutes are not expected to be fully mitigated.	• Construction and Pre-Production • Operations • Reclamation and Closure	Low	Yes
Change in Composition and Structure of Avalanche Chutes	<u>Erosion, Deposition of Dust and Airborne Deleterious Substances</u> • Implement the Air Quality and Greenhouse Gas Management Plan, the Soil Management Plan, the Erosion and Sediment Control Plan, the Vegetation and Ecosystems Management and Monitoring Plan, and the Spill Prevention, Control and Countermeasures Plan • Minimize the extent of disturbance within and adjacent to avalanche chutes. • Inspect erosion and sediment control measures • Education and training • Low speed limits • Regular road maintenance	• Recommended measures will contribute to the minimization of Project effects on avalanche chute composition and structure. • Effects of erosion, deposition of dust, and airborne deleterious substances in avalanche chutes are expected to be effectively mitigated such that a residual effect does not occur. • Effects on the composition and structure of avalanche chutes as a result of changes to disturbance regime are not expected to be fully mitigated. • Effects of invasive plants on the composition and structure of avalanche chutes are	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	Moderate to High	Yes (attributed to alteration of disturbance regimes only)

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	• Minimize earthworks during windy periods • Progressive reclamation and revegetation • Dust suppression methods • Proper covers/shielding where required • Monitor and inspect dust control measures <u>Change in Disturbance Regime</u> • Project design optimization • Limit the frequency of use and explosive potential for all explosives • Construct diversion berms and/or retention walls where avalanche chutes runout on to the Project Footprint • Schedule blasting during periods of relatively high stability in the snowpack, when feasible <u>Invasive Plant Species</u> • Implement the Vegetation and Ecosystems Management and Monitoring Plan • Control, manage, and remove invasive plants on site • Establish buffers and “no-work” zones where current infestations exist.	expected to be effectively mitigated such that a residual effect does not occur.			

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	• Restore with appropriate native vegetation • Education and training • Restrict traffic in known infested areas • Decontaminate vehicles and machinery				



Crown Mountain Coking Coal Project

Figure 13.6-1
Avalanche Chutes Ecosystem Loss

LEGEND

- Avalanche Chute Ecosystem Loss
- Avalanche Chute Ecosystem (Dominant)
- Avalanche Chute Ecosystem (Codominant)
- Avalanche Chute Ecosystem (Subdominant)
- Landscapes and Ecosystems Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- British Columbia/Alberta Border

0 1 2
Kilometres

N S E W

Scale 1:50,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, 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: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

Project: 12-6231
Status: FINAL
Date: 2022-01-11

Document Path: \\42dillon\CAD\GIS\2012 and Prior\126231 Crown Mountain\EA_Report\EffectsAssessment\Terrestrial\126231_EA_TEac_AvalancheChutesEcosystemLoss.mxd

Change in Abundance and Distribution of Avalanche Chutes

Avalanche chute ecosystems develop where terrain is steep enough to convey snow upon release from the associated start zone, but shallow enough to allow for development of soil and vegetation. The type of vegetation within an avalanche chute depends on not only its position and orientation in the landscape, but also on the disturbance regime of sliding snow that shears along the terrain surface, damaging vegetation or precluding growth beyond lower structural stages. Avalanche chutes with high severity and/or frequency of disturbance are less likely to support woody vegetation, and therefore are likely to be characterized by herbaceous meadows. Where avalanches occur with progressively lower severity and/or frequency, the vegetation community is more likely to support shrub and or tree species of increasing size.

Components of the Project footprint that overlap with avalanche chutes will result in the direct loss of such ecosystems. In particular, the Project overlaps with 69 ha of avalanche chute ecosystems, or 12% of the total associated area in the Landscapes and Ecosystems LSA (Table 13.5-8). Additionally, the Project may cause for avalanche chute ecosystems located outside of the Project footprint to be lost by permanent removal of their respective start zones. Removal of the avalanche start zone reduces the area of deposited snow that contributes to the disturbance regime of downslope avalanche chute ecosystems. Where the start zone is completely removed, the disturbance regime could be eliminated through removal of the source, causing downslope avalanche chutes to follow successional pathways towards more stable, climax ecosystems. Complete removal of avalanche start zones due to overlap with the Project footprint could potentially affect the abundance of up to 122 ha of avalanche chute ecosystems, equal to 20% of those ecosystems within the Landscapes and Ecosystems LSA.

Collectively, the Project has potential to cause direct and indirect loss of up to 191 ha, or 32% of the avalanche chute ecosystem area in the Landscapes and Ecosystems LSA, as a highly conservative upper estimate; however full development of the Project footprint is unlikely. In particular, the Project footprint includes a liberally estimated buffer of 250 m applied to the north and east boundary of the planned mine pit areas. This buffer is included for precautionary purposes only and is unlikely to be required outside of exceptional, unforeseeable circumstances to allow for removal of geotechnical hazards or to otherwise facilitate the safe and efficient extraction of coal. Although the exact extent cannot be predicted, it is reasonable to assume that the maximum area of disturbance will not exceed 25% of the total area of avalanche chute ecosystems in the Landscapes and Ecosystems LSA. This includes avalanche chute ecosystems that overlap with the mine pit areas, as well as those ecosystems that overlap with, or are located downslope from, the liberally estimated buffer of workspace. Although implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) will establish soil moisture and nutrient regimes similar to that of avalanche chute ecosystems, it is unlikely that disturbance regimes will be restored and/or maintained to the same degree and/or extent as that exhibited under baseline conditions. Consequently, it is predicted that a residual effect of a change in the abundance and distribution of avalanche chutes will occur.

Change in Composition and Structure of Avalanche Chutes

Where development of the mine pit areas results in incomplete removal of the respective start zones, avalanches may still occur, but with reduced severity and/or reduced frequency such that vegetation in avalanche chutes may shift towards ecosystems dominated by increased cover of woody species. For example, a herbaceous meadow avalanche chute may shift in composition to have a higher proportion, or potential dominance, of shrub species, changing the overall composition and structure to resemble a shrub thicket avalanche chute instead. Conversely, a shrub thicket avalanche chute may shift to include a higher proportion of tree species. Given that the Project cannot replace the start zones of avalanches located downslope from the mine pit areas, it is unlikely that disturbance regimes will be restored during the Reclamation and Closure phase of the Project. Although up to 122 ha, or 20% of the avalanche chute ecosystem area in the Landscapes and Ecosystems LSA, have the potential to be affected, it is unlikely that all related start zones will be required, as the Project footprint buffer from the mine pit areas is provided for exceptional, unforeseeable circumstances.

In addition to those areas that may be affected through partial removal of the respective avalanche start zones, the Project may result in further changes to the disturbance regime of avalanches in the Landscapes and Ecosystems LSA through avalanche control and blasting in the mine pit areas. Although implementation of the recommended mitigation measures will reduce the potential change in disturbance regimes of avalanche chutes, it is unlikely that complete avoidance will be possible, particularly during blasting and can completely mitigate the change. Given that associated changes in the disturbance regimes will occur during expansion of the mine pits, it is anticipated that the source of the potential effect will cease upon completion of the Operations phase. Where disturbance regimes are altered sufficiently to result in changes to the composition and structure of avalanche chute ecosystems, it may require an equivalent period to reverse the changes to baseline conditions.

13.6.3.3.3 Characterization of Residual Effects

Change in Abundance and Distribution of Avalanche Chutes

- Duration: Permanent, although reclamation activities will aim to restore herbaceous and shrub dominant vegetation types similar to avalanche chute ecosystems, the removal of avalanche chutes and their respective start zones, which support their associated disturbance regimes, cannot be replaced.
- Magnitude: Moderate, the Project footprint will result in the loss of between 12% and 25% (as a reasonably conservative upper limit) of the avalanche ecosystems in the Landscapes and Ecosystems LSA. Removal of all avalanche chutes or permanent loss of avalanche chute ecosystems outside of the Project footprint extending up to the maximum potential area of 32% of the Landscapes and Ecosystems LSA is not anticipated.
- Geographic Extent: Local, the loss of avalanche chute ecosystems will be limited to the Project footprint and immediately downslope locations within the Landscapes and Ecosystems LSA.
- Frequency: Once, the removal of avalanche chute areas and/or their start zones can only occur once, but will be conducted incrementally and sequentially over the Operations phase of Project development.
- Reversibility: Irreversible, as implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) will not restore the disturbance regimes of reconstructed alpine communities, or retained avalanche chute ecosystems located outside of the Project footprint.
- Context: Neutral, although no ecosystem is resilient to complete removal, there is potential that some sliding activity may remain within retained avalanche chutes downslope from the Project.

Determination of Significance

The residual effect on the abundance and distribution of avalanche chute ecosystems is considered to be not significant. Although construction, extraction of materials, and deposition of mine rock will result in the unavoidable, permanent loss of avalanche chutes and start zones for those areas outside of the Project footprint, the magnitude of the maximum potential effect is considered to be highly conservative due to the overestimated buffer applied to the mine pit areas, and is therefore not predicted to occur to the full extent (i.e., 32% of the avalanche chutes in the Landscapes and Ecosystems LSA). Consequently, although the residual effect is considered to be irreversible, the magnitude is not likely to exceed a rating of “moderate”, and therefore is considered to be not significant.

Likelihood and Confidence

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

Although it is reasonably certain that removal of avalanche chutes and associated start zones will be required, the full extent, particularly within the buffered area outside of the mine pits, is not well defined. Consequently, the determination of significance is assessed to have only a moderate level of confidence; however, this level of confidence is reflected in the conservatism included in the predicted area of impact. In the event that other VC specific mitigation measures depend on the area of residual effect to avalanche chute ecosystems, then additional monitoring and delineation of the extent of avalanche chute ecosystems may be required in the Reclamation and Closure phase.

Change in Composition and Structure of Avalanche Chutes

- Duration: Permanent, although alteration of the disturbance regimes will occur throughout the Construction and Pre-Production and Operations phases of the Project, residual effects associated with partial removal of the respective avalanche start zones will extend beyond the Post-Closure phase of the Project.
- Magnitude: Moderate, the area of avalanche chute ecosystems subjected to avalanche control measures, within sufficient proximity to mine blasting activities and those areas downslope from the area of removed start zones, is not likely to exceed 25% of the avalanche chute ecosystems in the Landscapes and Ecosystems LSA.
- Geographic Extent: Local, the alteration of disturbance regimes affecting avalanche chute ecosystems is anticipated to extend immediately downslope from the Project footprint, within the Landscapes and Ecosystems LSA.
- Frequency: Once to Regular, removal of avalanche chute areas and/or their start zones can only occur once, but will be conducted incrementally and sequentially over the Operations phase of Project development, while blasting and avalanche control measures are anticipated to occur regularly.
- Reversibility: Reversible Long-Term to Irreversible, cessation of avalanche control measures and blasting activities will allow for restoration of disturbance regimes; however, reclamation will not completely restore the start zones for all avalanche chute ecosystems located outside the Project footprint.
- Context: Neutral, although no ecosystem is resilient to complete removal, there is potential that some sliding activity may remain within retained avalanche chutes downslope from the Project.

Determination of Significance

The alteration of composition and structure of avalanche chute ecosystems due to changes in disturbance regime is considered to be not significant. Although there is potential for the Project to result in permanent, irreversible change to the disturbance regime of avalanche chute ecosystems outside of the Project footprint, the calculated maximum potential extent of the residual effect includes a high degree of conservatism to allow for extenuating, unplanned circumstances. Implementation of the recommended mitigation measures (e.g., avalanche diversion berm/retention wall) will reduce the need for avalanche control; however, blasting within the mine pit areas cannot be avoided, and will likely destabilize the snowpack in retained avalanche chute ecosystems closest to the Project on occasion. Changes to the composition and structure of avalanche chute ecosystems are anticipated to reverse over the Post-Closure phase with cessation of blasting activities and closure of the Project; however, any localized partial removal of avalanche start zones is anticipated to result in irreversible incursion of woody species in avalanche chutes downslope from the Project.

Likelihood and Confidence

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

Although it is reasonably certain that removal of avalanche chutes and associated start zones will be required, the full extent, particularly within the buffered area outside of the mine pits, is not well defined. Although the characterization of residual effects considers the maximum potential extent within which composition and structure of avalanche chutes may be affected, the exact response of vegetation in these areas is not readily predictable due to a lack of confidence in species-specific responses. For example, willow species (Salix spp.) readily spread through growth of roots and underground stems, whereas other species (e.g., subalpine fir [Abies lasiocarpa]) rely more on the germination of seeds in the soil seed bank, which may occur much more slowly than lateral, vegetative growth. Consequently, some avalanche chute ecosystems may adapt to altered disturbance regimes faster than others; however, the degree of change cannot be readily predicted. Consequently, the determination of significance is assessed to have only a moderate level of confidence.

13.6.3.3.4 Summary of Residual Effects Assessment

Residual effects for avalanche chutes and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 13.6-4. Significant residual effects to avalanche chutes are not anticipated as a result of the Project.

13.6.4 Project Effects on Grasslands

13.6.4.1 Discussion of Potential Effects

In general, the Project has the potential to affect grassland ecosystems through:

- Direct reduction in grassland abundance and distribution due to site clearing and grubbing, logging of timber, and soil movement/salvage;
- Indirect loss or changes in grassland composition due to site clearing and soil movement/salvage, introduction and spread of invasive plant species, and encroachment of adjacent forest ecosystems; and

Table 13.6-4: Summary of Residual Effects on Avalanche Chutes

Valued Component	Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Likelihood (High, Moderate, Low)	Confidence (High, Moderate, Low)
Avalanche Chutes	Change in Abundance and Distribution of Avalanche Chutes	• Construction and Pre-Production • Operations	• Project design optimization • Implementation of the Ecological Restoration Plan and the Vegetation and Ecosystems Management and Monitoring Plan • Minimizing disturbance and cleared areas • Construct diversion berms and/or retention walls where avalanche chutes runout on to the Project footprint • Schedule blasting during periods of relatively high stability in the snowpack, when feasible	Duration: Permanent Magnitude: Moderate Geographic Extent: Local Frequency: Once Reversibility: Irreversible Context: Neutral	Not Significant	Not Applicable	Moderate
	Change in Composition and Structure of Avalanche Chutes	• Construction and Pre- Production • Operations • Reclamation and Closure	• Project design optimization • Limit the frequency of use and explosive potential for all explosives • Implementation of the Vegetation and Ecosystems Management and Monitoring Plan	Duration: Permanent Magnitude: Moderate Geographic Extent: Local Frequency: Once to Regular Reversibility: Reversible Long-Term to Irreversible Context: Neutral	Not Significant	Not Applicable	Moderate

Valued Component	Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Likelihood (High, Moderate, Low)	Confidence (High, Moderate, Low)
			• Construct diversion berms and/or retention walls where avalanche chutes runout on to the Project Footprint • Schedule blasting during periods of relatively high stability in the snowpack, when feasible				

- Reduction in vegetation vigour due to dust deposition associated with construction, transportation, mining, and coal processing activities.

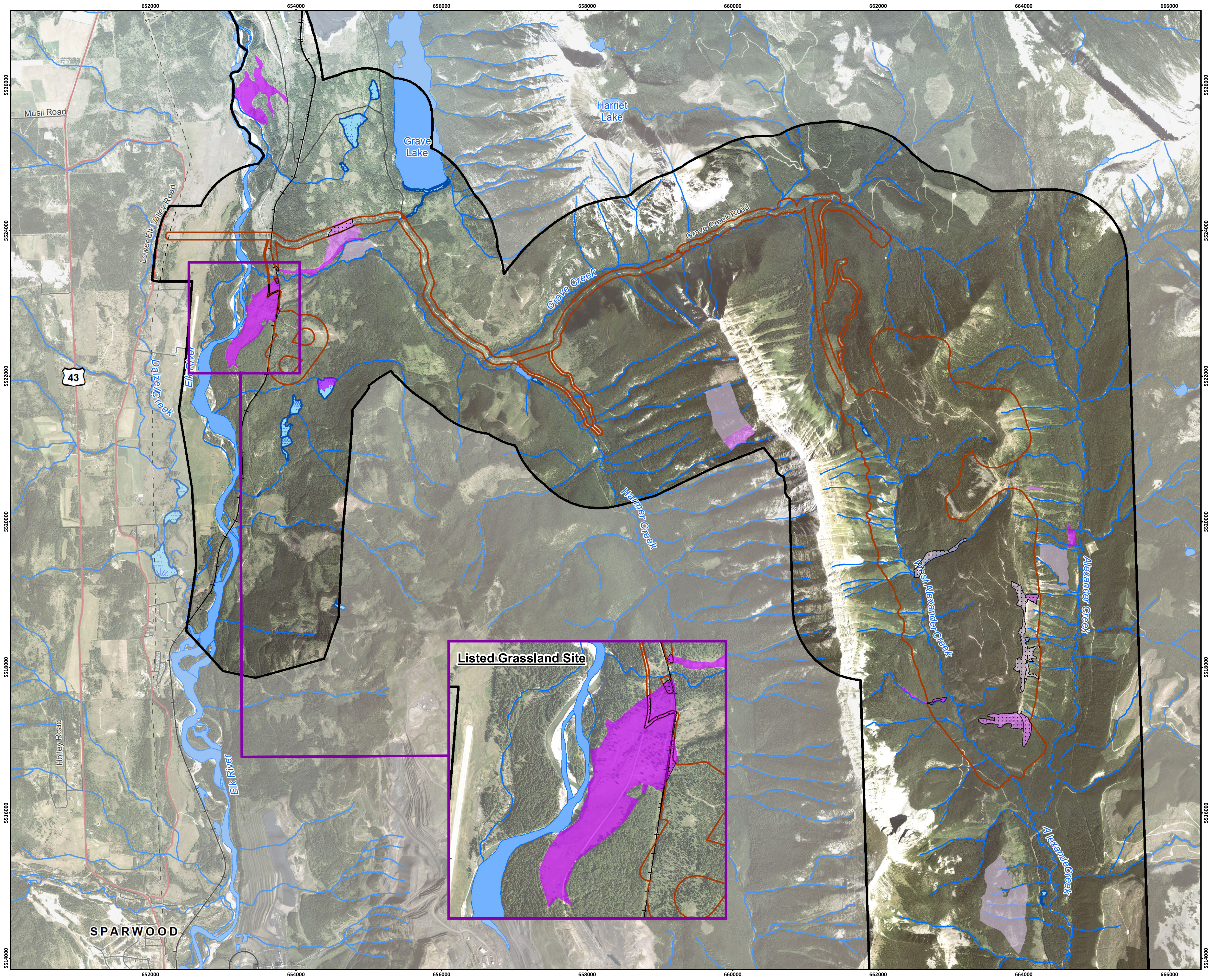
Potential effects on grasslands due to the Project that are carried forward in the discussion of potential effects are identified in Table 13.6-5 and discussed in the context of each Project phase below.

Table 13.6-5: Potential Effects on Grasslands

Potential Effect	Rationale for Selection of Environmental Effect
Change in Grassland Abundance and Distribution	Activities including site clearing, construction, removal and movement of soil, rail loadout construction, and reclamation may result in changes to the size and location of grassland ecosystems through impacts on site reclamation potential and the potential decrease in ability to restore sites to an equivalent pre-disturbance condition. Soil quality may be affected by admixing if proper soil management is not carried out. Reduced soil quantity may affect revegetation and ecosystem development during reclamation.
Change in Grassland Composition and Structure	The direct loss of grassland ecosystems has the potential to result in indirect effects to the remaining intact grasslands adjacent to the areas of disturbance as a result of Project development. Vegetation removal and soil disturbance (removal and compaction of soils) within the Project footprint may alter the plant community, soil structure, and wildlife behaviours around areas of disturbance, resulting in changes to grassland ecosystem composition and structure.
	Increased vehicle traffic, stockpiling of salvaged soil, transportation of soil, and reclamation have the potential to introduce non-native species to grassland ecosystems. The increase in non-vegetated soil throughout the Project footprint during reclamation activities may lead to increased establishment of non-native plant species. Invasive species can result in changes to grassland composition and structure.
	The increase in non-vegetated soil throughout the Project footprint during reclamation activities may create opportunities for encroachment of plant species from adjacent forested areas into reclaimed areas previously occupied by grassland ecosystems. This encroachment can result in changes to grassland composition and structure.
Change in Grassland Vegetation Vigour	Project activities such as site clearing, construction, removal and movement of materials, detonating of explosives, maintenance, and long-term traffic may result in increased dust and deposition on vegetation, reducing vegetation vigour, potentially altering species composition and habitat value.

13.6.4.1.1 Change in Grassland Abundance and Distribution

The Project is conservatively expected to result in the direct loss of 12 ha of grassland ecosystems (Figure 13.6-2; Table 13.5-10). Grassland ecosystems within the Project footprint are anticipated to be directly lost as a result of site preparation and construction activities during Construction and Pre-Production, and removal of unconsolidated material during Operations. The abundance and distribution of grasslands may be lost and permanently altered during the Construction and Pre-Production and Operations phases.



Crown Mountain Coking Coal Project

Figure 13.6-2
Grassland Ecosystem Loss

LEGEND

- Grassland Ecosystem Loss
- Grassland Ecosystem (Dominant)
- Grassland Ecosystem (Codominant)
- Grassland Ecosystem (Subdominant)
- Landscapes and Ecosystems Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- British Columbia/Alberta Border

0 1 2
Kilometres

Scale 1:50,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, 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/LMM
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

Project: 12-6231
Status: FINAL
Date: 2022-01-11

Document Path: \\42dillon\CAD\GIS\2012 and Prior\126231 Crown Mountain\EA_Report\EffectsAssessment\Terrestrial\126231_EA_TEgl_GrasslandHabitatLoss.mxd

Construction and Pre-Production

Potential effects on the abundance and distribution of grassland ecosystems are anticipated to occur during the Construction and Pre-Production phase through site clearing, removal and movement of soil, road upgrades, and construction of the rail loadout and service corridor. These activities are conservatively anticipated to result in the direct loss of 2.78 ha of grassland abundance and distribution within the Project footprint due to vegetation clearing and soil removal. The grassland site classes that will be affected by these activities include the following:

- 1.35 ha of Gb (brushland);
- 0.36 ha of Gb04 (choke cherry – snowberry – bluebunch wheatgrass);
- 0.02 ha of Gg (grassland); and
- 1.07 ha of Gg12 (rough fescue – [bluebunch wheatgrass] – yarrow – clad lichens; designated as a Red-listed ecological community [B.C. CDC, 2018b]).

Operations

Direct loss of grassland ecosystems will continue during Operations with progressive clearing of pits and mine rock storage areas. This will conservatively result in a further loss of 9.67 ha of grassland ecosystem abundance and distribution within the Project footprint. These grassland areas were all classified as site class Gb20 (saskatoon – soopolallie – juniper).

Reclamation and Closure

The planned reclamation of ecosystems and landscapes in the Reclamation and Closure phase is anticipated to result in an increase to grassland ecosystem extent in the Project footprint, over time, as detailed in the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3). A total area of 181 ha of grassland ecosystems will be reclaimed.

Project access roads, including Valley Road, Grave Creek Road, and the road to the rail loadout, will remain as a permanent features in the Post-Closure mine environment. Valley Road will remain as a local road as it currently operates. These permanent features will result in the permanent loss of approximately 1 ha of grassland ecosystems.

Post-Closure

No potential adverse effects to grassland abundance and distribution are anticipated to occur during the Post-Closure phase that did not occur in previous phases. Monitoring programs implemented during the Post-Closure phase will include assessments of reclaimed areas throughout the Project footprint to evaluate the success of completed reclamation activities, and determine the requirement for subsequent efforts to maintain the trajectory of restoring grassland abundance and distribution to a condition equivalent to or exceeding pre-construction conditions. Access roads, including Valley Road, Grave Creek Road, and the road to the rail loadout, will remain as a permanent features in the Post-Closure mine environment.

13.6.4.1.2 Change in Grassland Composition and Structure

Grassland ecosystems adjacent or in close proximity to the Project footprint have the potential to experience alteration of composition and structure as a result of Project activities. Composition and structure of grassland ecosystems can be altered as a result of the introduction and spread of invasive plant species, and indirect alteration of vegetation communities, soil structures, and wildlife behaviour around areas of direct disturbance.

Construction and Pre-Production

Activities in the Construction and Pre-Production phase create the greatest opportunity for the introduction and spread of invasive plant species and result in an increased potential for grassland ecosystems to be impacted. In particular, ground disturbance through vegetation and soil removal, use of the access roads, and use of unwashed vehicles and machinery onsite increase the potential for the spread of invasive and agronomic plants. The disturbance and movement of soils adjacent to grasslands during site preparation and the upgrading of access roads have the potential to create an opportunity for invasive establishment as exposed soils create optimal conditions for invasive plants to spread rapidly. Vehicles and machinery can transport invasive plant seeds or plant parts from infested areas beyond the Project footprint. Invasive plants can alter ecosystem composition and structure by outcompeting native vegetation communities and reducing the abundance of native species that comprise an ecological community (Adams et al., 2016). These alterations in plant community composition can subsequently result in the transition of a grassland ecosystem towards an early-seral stage condition.

Alterations in soil quality and quantity during the Construction and Pre-Production phase may affect the composition and structure of grassland ecosystems. Soil removal and compaction within the Project footprint through the use of heavy equipment may result in indirect effects to soils within grassland areas, within an area of influence around the Project footprint, potentially upwards of 50 m from the direct areas of disturbance. Compaction of soils can result in the degradation of soil fertility and reduce a plant community's ability to support plant growth. Soil compaction can also affect water infiltration (Hoorman et al., 2011) and create long recovery times for plant communities in grassland ecosystems (Krzic et al., 2013). Changes in soils and moisture regime in grassland ecosystems may contribute to forest encroachment, a threat that has reduced the ecological integrity of grasslands in the Landscapes and Ecosystems LSA, particularly the Red-listed Gg12 ecological community (B.C. CDC, 2018b). Additionally, improper soil management practices during the Construction and Pre-Production phase have the potential to affect soil quality through admixing, and soil quantity through erosion and sediment transfer, which may affect reclamation success during the Reclamation and Closure phase.

Project-related impacts to soils during the Construction and Pre-Production phase may also indirectly affect the composition and structure of grassland ecosystems through the removal or compaction of soils that support a biological soil crust. Removal of vegetation from within the Project footprint may indirectly alter the ecological community beyond the direct area of disturbance, resulting in higher soil temperatures, increased evaporation, and reduced soil moisture availability (MacKillop et al., 2018). Disturbance associated with vegetation removal and soil conditions can alter the biological crust species composition by reducing moss and lichen cover (MacKillop et al., 2018). Loss of the biological soil crust can lead to increased risk of soil erosion from wind and water, reduction of the carbon and nitrogen contributions to soil, and reduction in soil water infiltration (Rosentreter et al., 2007).

Operations

Over the course of the Operations phase, Project activities have the potential to spread and introduce invasive plant species through the use of access roads, the utility corridor, and the traffic from off-site and unwashed vehicles and machinery. Invasive plants are commonly found along roads in B.C., and with the proximity of the grasslands within and adjacent to the Project footprint, there is potential for the introduction and spread of invasive plants within these ecosystems.

Potential effects on grassland composition and structure are anticipated in the Operations phase through the loading, hauling, and stockpiling of soil, coal, and mine rock. Impacts to grasslands through removal of soils may include admixing and introduction of invasive and agronomic species, which may alter the composition and structure of grasslands.

Reclamation and Closure

As with Construction and Pre-Production and Operations phases, invasive and agronomic plant species may be introduced or spread within grassland ecosystems during the Reclamation and Closure phase as materials are transported to and from the Project footprint for the decommissioning of mine infrastructure.

Reclamation activities will include de-compaction of subsoils, replacement and re-contouring of salvaged topsoil, and implementation of appropriate revegetation programs in areas disturbed during the Construction and Pre-Production and Operations phases, as detailed in the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3). These activities are anticipated to result in a positive effect on composition and structure of grassland ecosystems within and adjacent to the Project footprint, as the vegetation communities within reclaimed areas of the Project footprint are established over subsequent growing seasons.

Post-Closure

No potential adverse effects to grassland composition and structure are anticipated to occur during the Post-Closure phase that did not occur in previous phases. Monitoring programs implemented during the Post-Closure phase will include assessments of reclaimed areas throughout the Project footprint to evaluate the success of completed reclamation activities, and determine the requirement for subsequent efforts to maintain the trajectory of restoring grassland composition and structure to a condition equivalent to pre-construction conditions. These programs will include continued vegetation management strategies to prevent the introduction or spread of invasive plant species within grassland ecosystems. Additionally, vegetation management strategies will be implemented to mitigate forest encroachment into grassland ecosystems.

13.6.4.1.3 Change in Grassland Vegetation Vigour

Grassland ecosystems within close proximity to the Project footprint have the potential to experience alteration in vegetation vigour due to dust deposition over the course of Project activities.

Construction and Pre-Production

Activities during the Construction and Pre-Production phase have the potential to adversely affect plant vigour within grassland ecosystems due to the generation of dust. Dust generation may occur as a result of the construction and upgrading of access roads, construction of the rail loadout and associated infrastructure, and use of the access roads to transport materials to/from the site. Dust deposition within the Red-listed Gg12 ecological community, which spans the road upgrading area and occurs adjacent to the rail loadout, may result in reduced vegetation vigour of plants within the Red-listed community, thereby affecting the ecological community's ability to sustain and thrive within the already disturbed area. Lichens, which commonly comprise soil biological crusts, can accumulate atmospheric contaminants from dust and be very sensitive to changes in air quality (Berryman et al., 2009). As such, dust deposition on the soil crust of the Gg12 ecological community may be negatively affected as a result of construction activities.

Operations

The generation of dust during the Operations phase is anticipated to occur around the Project footprint through the loading, hauling, and stockpiling of soil and mine rock. Through the Operations phase, these activities may result in increased dust. As described above, dust deposition can have adverse effects on vegetation during growing season periods, through increased deposition and increased airborne particulate matter, and changes to soil and vegetation chemistry.

Reclamation and Closure

Over the course of the Reclamation and Closure phase, limited amounts of dust may be generated through the decommissioning of site infrastructure, reclamation of disturbed areas, and use of transportation corridors (i.e., Grave Creek Road) as materials are moved from the site; however, decreased site activities and lower frequency of vehicle and equipment travel will result in less dust generation, compared to the Construction and Pre-Production and Operations phases.

Post-Closure

No potential adverse effects to grassland vegetation vigour are anticipated to occur during Post-Closure. Access roads and the rail loadout will remain as a permanent features in the Post-Closure mine environment; however, the potential dust deposition resulting from Post-Closure activities is not anticipated to adversely affect grassland vegetation vigour, due to the expected low frequency of vehicle and equipment traffic associated with these activities.

13.6.4.1.4 Transboundary Effects

As described in Section 13.6.3.1.3, the Project is located approximately 5 km west of the Alberta border, approximately 85 km north of the Montana border, and does not overlap with federal lands. The most frequent wind direction recorded at the Project baseline climate station was from the southeast while the wind data recorded at the Sparwood CS station is predominant northerly and southerly. The atmospheric environment assessment (Chapter 6, Section 6.5.4.2.1) concluded that no measureable transboundary effects on air quality in Alberta, the United States, or on federal lands are anticipated to occur as a result of the Project. As such, no transboundary effects to grasslands as they relate to fugitive dust or changes in air quality are anticipated to occur.

13.6.4.2 Mitigation Measures

The mitigation measures proposed for grassland ecosystems are based on available BMPs, guidance documents, mitigation measures conducted 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 (B.C. MOE, 2014a and B.C. MOE, 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 grassland ecosystems. For the purposes of this assessment, mitigation measures are defined to include Project design features, procedures, or practices that are intended to reduce or eliminate Project-related effects to grassland ecosystems. Potential Project-related changes to grassland ecosystems will be reduced through design mitigation, adherence to regulatory requirements, and BMPs, including management plans, monitoring, and adaptive management. Where mitigation measures are considered completely effective, potential Project effects to grassland ecosystems are not identified as residual effects.

The following subsections describe measures to mitigate the potential Project effects on grassland ecosystems, including those for a change in abundance and distribution, a change in composition and structure, and a change in vegetation vigour.

13.6.4.2.1 Mitigation Measures for Change in Grassland Abundance and Distribution

Clearing and grubbing of vegetation, and the removal, transportation, and stockpiling of substrates all have the potential to result in the reduction of, or changes to, grassland abundance and distribution. The primary measure to mitigate changes in grassland abundance and distribution is to avoid grassland ecosystems altogether. Where avoidance within the Project footprint is not possible, the direct loss of grassland ecosystems will be addressed through a series of mitigation measures. As part of the Reclamation and Closure phase, grassland ecosystems within the Project footprint will be restored through implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3).

To mitigate the change in abundance and distribution of grassland ecosystems within the Project footprint over the course of the Project, the following mitigation measures will be implemented:

- Project design optimization to use existing access roads and areas of existing disturbance;
- Minimize disturbance and encroachment into grassland ecosystems to the extent feasible, by clearing and grubbing only what is required to safely complete the activities associated with the Construction and Pre-Production and Operations phases of the Project;
- Conduct pre-construction surveys to delineate “no-work” zones to establish buffers and setbacks around the listed Gg12 ecological community to avoid disturbance, where possible;
- Implement the Soil Management Plan (Chapter 33, Section 33.4.1.9) to salvage and stockpile soils from grassland areas removed during the Construction and Pre-Production phase for future reclamation activities;
- Use the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4) to reduce indirect impacts to adjacent vegetated grassland areas;
- Apply progressive reclamation as sites become available;
- Follow the measures and post-reclamation monitoring outlined in the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3); and
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to listed ecological communities.

13.6.4.2.2 Mitigation Measures for Change in Grassland Composition and Structure

Project activities, including site clearing and grubbing, vegetation removal, and soil disturbance (removal and compaction) within the Project footprint, as well as use of access and haul roads, have the potential to indirectly affect and alter grassland composition and structure. Plant community composition and structure in grassland ecosystems may be affected within an area of influence around the Project footprint through the introduction and spread of invasive plants and the alteration of vegetation and soil structures. Avoidance is the best measure to reduce the potential for changes in grassland composition and structure. In conjunction with avoidance, specific strategies to control potential indirect effects from Project activities will be implemented to reduce the potential for invasive species introduction and alteration of composition and structure as a result of ground disturbance and vegetation removal.

Invasive Plants

Invasive plant species plants can establish quickly and easily on both disturbed and undisturbed areas and cause wide-spread negative economic, social, and environmental impacts (ISCBC, 2019). Project activities during the Construction and Pre-Production, Operations, and Reclamation and Closure phases can encourage invasive plant establishment and spread through machinery and vehicle operation, ground disturbance activities, and use of potentially infested soils or materials within the Project footprint. Implementation of the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11) and specific measures to control and eradicate invasive plants is integral to protecting grassland ecosystems.

Prior to construction, it is anticipated that a Project-specific management plan for invasive plants will be developed as an operational guide to manage invasive plants within the Project footprint. The plan will be implemented over the course of the Project to control existing and future invasive plant populations.

Measures to control existing invasive plant populations and reduce the potential for the introduction of additional invasive plants during the Construction and Pre-Production, Operations, and Reclamation and Closure phases include:

- Identify and demarcate invasive plant populations within and adjacent to sensitive plant populations and ecological communities prior to construction or on-site activities;
- Establish setback areas and "no-work" areas if invasive plant populations are located near areas of disturbance to reduce the spread of invasive plants by machinery and vehicles;
- Remove existing plant populations to prevent the spread to adjacent areas;
- Undertake invasive control activities, including distribution of biocontrol agents, and mechanical and chemical treatments, as necessary;
- Reduce exposure of bare ground during disturbance activities;
- Restore sites with native vegetation species following treatment of invasive infestations and ground disturbance to establish vegetative cover;
- Establish an Early Detection and Rapid Response (EDRR) system in accordance with the Government of B.C. guidance (e.g., Inter-Ministry Invasive Species Working Group, 2014) and monitor for new invasive plants of concern through the follow-up and monitoring programs (Chapter 33);
- Restrict vehicle and machinery traffic to designated access roads;
- Decontaminate vehicles and machinery leaving work areas;

- Apply contouring and erosion control measures to limit spread of invasive and agronomic species seed and plants;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to listed plant populations and listed plant ecological communities; and
- Monitor disturbed areas and areas where invasive plants were removed to evaluate effectiveness of mitigation and control measures.

Additional mitigation measures related to invasive species management are provided in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

Vegetation Removal and Soil Disturbance

The Project design optimizes the use of the existing access roads (e.g., Valley Road and Grave Creek Road) as transportation corridors to and from the Project footprint. Indirect effects on grassland ecosystems could occur as a result of vegetation removal and soil disturbance. Grassland composition and structure may be indirectly impacted as areas adjacent to the Project footprint experience soil degradation, an increased threat to forest encroachment due to soil and vegetation changes, and alteration of the biological soil crust.

The following mitigations will be implemented to reduce the potential for indirect adverse effects to grassland ecosystems adjacent to the Project footprint:

- Project design optimization to use existing access roads and areas of existing disturbance;
- Conduct pre-construction surveys to delineate “no-work” zones to establish buffers and setbacks around listed plant populations and the listed plant community to avoid disturbance, where possible;
- Conduct pre-construction surveys to identify exclusion “no-work” zones in areas with biological soil crust and reduce disturbance in these areas, where possible;
- Make site-specific adjustments, where possible, to avoid listed plant populations and listed grassland ecological communities, including areas with established biological soil crust;
- Minimize disturbance to the extent feasible, by clearing and grubbing only what is required to safely undertake activities during the Construction and Pre-Production and Operations phases of the Project;
- Retain vegetated and ground cover where possible to prevent soil erosion and maintain soil temperatures;
- Revegetate disturbed areas with native vegetation soon after disturbance to re-establish vegetative cover;
- Minimize compaction of soils as per the Soil Management Plan (Chapter 33, Section 33.4.1.9);
- Use the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4) to reduce indirect impacts to adjacent vegetated areas;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to intact ecological communities adjacent to the Project footprint;
- Complete construction activities during periods of least risk windows to minimize impacts to sensitive periods for terrestrial species as per provincial and federal legislation and the strategies outlined in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11); and

- Monitor select locations within grassland ecosystems to determine changes in plant composition and structure over time and evaluate revegetation of disturbed areas adjacent to the Project footprint.

13.6.4.2.3 Mitigation Measures for Change in Grassland Vegetation Vigour

Dust has the potential to be generated through Project activities during the Construction and Pre-Production and Operations phases. The Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1) will be used over the course of the Project to implement measures to avoid and minimize dust generation and deposition and reduce the potential for effects on vegetation vigour in grassland ecosystems.

Specific mitigation measures to be used to control the generation and deposition of dust and reduce the potential for adverse effects on grassland vegetation vigour include but are not limited to:

- Project design optimization to reduce travel distances between Project infrastructure components;
- Create exclusion zones around listed plant populations and listed plant communities, where possible through implementation of the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1);
- Conduct soil handling activities during the Construction and Pre-Production phase in a manner that reduces exposed soils and avoids dust-generating activities during windy periods, where feasible;
- Design and construct access roads with the goal of keeping dust levels as low as reasonably achievable, which may include the use of coarser aggregate material on haul roads and/or pavement of high traffic areas;
- Maintain unpaved roads and keep in good repair, including regular road compaction and use of coarse aggregate with low silt content, where possible;
- Apply and use dust suppression measures such as wetting work areas and stockpiles, installing equipment covers, and using dust hoods and shields at the rail loadout;
- Locate soil stockpiles at appropriate locations that avoid listed plant populations and listed ecological communities, and construct stockpiles using designs that allow for slope stability and reduce moisture content loss, including establishment of vegetation to reduce exposure to wind and water erosion;
- Implement the Soil Management Plan (Chapter 33, Section 33.4.1.9);
- Enforce low speed limits for vehicular traffic throughout the site, such as along access roads to the rail loadout;
- Decontaminate vehicles and machinery leaving work areas;
- Cover haul trucks using Valley Road and the access road to the rail loadout to reduce deposition of fugitive dust;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to sensitive vegetation and ecosystems; and
- Monitor and inspect air quality and dust control measures to evaluate effectiveness and functionality and allow for timely maintenance and adjustments as required.

13.6.4.2.4 Summary of Mitigation Measures for Grasslands

The key mitigation measures proposed to mitigate potential effects on grasslands are summarized in Table 13.6-6. Anticipated residual effects that will be carried forward in the characterization of residual effects, significance, and likelihood and confidence are outlined in Table 13.6-6.

Mitigation measures proposed to reduce adverse effects to grassland ecosystems are generally accepted, understood, and proven to effectively reduce adverse effects on ecosystem abundance and distribution, composition and structure, and grassland vegetation vigour. Where mitigation measures do not or may not mitigate all effects or if there is a low 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.

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 Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

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

Based on the evaluation of potential Project effects on grassland ecosystems, potential residual effects that may remain after implementation of measures to avoid and minimize adverse effects include:

- Change in grassland abundance and distribution and
- Change in grassland composition and structure as a result of vegetation removal and soil disturbance.

13.6.4.3.1 Assessment Methods

The characterization of residual effects follows methods outlined in Chapter 5, Section 5.3.4.5. Ecosystem-specific methods used in the assessment of residual effects are detailed below, if applicable.

A footprint analysis was used to determine areas of the Project footprint that overlap and interact with grassland ecosystems. The maximum Project footprint extent, including clearing and contingency areas, presents the maximum extent of disturbance associated with the Project. Interaction between the mapped grassland ecosystem extent and the Project footprint is considered a conservative direct loss of grassland ecosystem abundance in the Landscapes and Ecosystems LSA.

Given the complexity of relationships among species and the abiotic environment, and that not all mechanisms of impact act equally in all locations at all times, characterization of changes in grassland composition and structure was conducted qualitatively in consideration of industry best practices and the professional judgement of the authors.

Table 13.6-6: Summary of Proposed Mitigation Measures Related to Grasslands

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Grassland Abundance and Distribution	• Project design optimization • Minimizing disturbance and cleared areas • Establish exclusion / "no work" zones and setback buffers • Education and training • Implementation of the Soil Management Plan • Implementation of the Erosion and Sediment Control Plan • Implement the Vegetation and Ecosystems Management and Monitoring Plan and the Ecological Restoration Plan	• Measures contribute to the avoidance, minimization, and restoration of grassland ecosystem losses associated with construction, mining, and operational management activities. • Effects of Project development on grassland ecosystems are not expected to be fully mitigated.	• Construction and Pre-Production • Operations • Reclamation and Closure	Moderate	Yes
Change in Grassland Composition and Structure	Invasive Plants: • Implementation of the Vegetation and Ecosystems Management and Monitoring Plan • Control, manage, and remove invasive plants on site • Identify and demarcate invasive plant populations • Establish exclusion / "no work" zones and setback buffers. • Reduce areas of exposed soils • Restore with appropriate native vegetation • Restrict traffic in known infested areas • Decontaminate vehicles and machinery • Education and training	• Prevention of the introduction and movement of invasive plants on site is important to controlling the effects of invasive plant species on grassland ecosystems. Management strategies proposed contribute to the avoidance and minimization of effects of invasive plants on grassland ecosystems. EDRR systems can be effective in limiting and preventing the spread of invasive plants. • Effects of invasive plants on grassland ecosystems are expected to be effectively mitigated such that a residual effect does not occur.	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	Vegetation Removal and Soil Disturbance: • Project design optimization. • Establish exclusion / “no work” zones and setback buffers • Minimizing disturbance and cleared areas • Retain vegetation and groundcover • Restore with appropriate native vegetation • Adhere to least risk windows • Minimize soil compaction • Implementation of Soil Management Plan • Implementation of Erosion and Sediment Control Plan • Implementation of the Vegetation and Ecosystems Management and Monitoring Plan • Education and training • Monitor changes in plant community and areas of revegetation	• Measures allow for the reduction of effects resulting from changes in grassland composition and structure due to vegetation removal and soil disturbance within the Project footprint and area of alteration around the footprint. • Effects of vegetation removal and soil disturbance on grassland composition and structure are not expected to be fully mitigated.	• Construction and Pre-Production • Operations	Moderate	Yes
Change in Grassland Vegetation Vigour	• Project design optimization • Implementation of Air Quality and Greenhouse Gas Management Plan • Implementation of Vegetation and Ecosystems Management and Monitoring Plan • Implementation of the Soil Management Plan	• Dust reduction strategies will reduce dust deposition on listed plant populations and listed plant ecological communities. • Effects of dust on listed plants and plant communities are expected to be effectively mitigated such that a residual effect does not occur.	• Construction and Pre-Production • Operations	High	No

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	• Exclusion zones • Dust suppression methods • Manage machinery and vehicle speed limits • Vehicle covers and decontamination • Road maintenance • Manage timing of construction and earthmoving activities • Education and training • Monitor and inspect dust control measures				

13.6.4.3.2 Potential Residual Effects Assessment

Change in Grassland Abundance and Distribution

The reduction in geographic extent of grassland ecosystems within the Project footprint represents a residual effect as a result of site clearing and grubbing in preparation for road upgrading and the salvaging and stockpiling of soils. Although effects to grassland ecosystems will be minimized through Project design (e.g., through the use of existing access roads and disturbance areas that bisect grassland ecosystems), it is unlikely the direct impacts to grasslands will be completely avoided in the Construction and Pre-Production and Operations phases.

Under a maximum potential impact scenario of development, whereby the Project is conservatively assumed to result in the direct loss of all grassland areas present in the Project footprint, these activities are anticipated to result in the overall direct loss of 12.47 ha of grassland area within the Project footprint. This represents an overall direct loss of 6.23% of the total amount of available grassland ecosystem area in the Landscapes and Ecosystems LSA, as detailed in Table 13.6-7. Of the grassland areas that will be directly lost as a result of Project activities, 1.07 ha of the Red-listed Gg12 Rough fescue - (bluebunch wheatgrass) - yarrow - clad lichens ecological community is conservatively anticipated to be directly lost as a result of site preparation and construction activities, representing a 3.99% loss of the available ecological community within the Landscapes and Ecosystems LSA.

With the exception of class Gb20 grasslands, the areas of grassland directly impacted as a result of Project construction and site disturbance occur within and adjacent to areas of existing disturbance (i.e., access roads and rail lines), limiting impacts to grassland habitat availability and the abundance and distribution of the ecological community. Grassland abundance and distribution will be slightly reduced due the permanent loss of 3 ha of grasslands within the Project footprint; however, the extent of direct loss is not expected to affect the distribution and abundance of the community in the Landscapes and Ecosystems LSA or the Elk Valley.

Table 13.6-7: Change in Grassland Ecosystem Abundance within the Landscapes and Ecosystems LSA

BGC Unit	Grassland Ecosystem Class	Project Footprint Extent (ha)[1]	Landscapes and Ecosystems LSA Extent (ha)	Proportion of Change in Landscapes and Ecosystems LSA from Project Footprint (%)
MSdw	Ga03$	0.00	1.87	0.00
	Gb	1.35	52.26	-2.58
	Gb04	0.36	58.41	-0.61
	Gg	0.02	5.93	-0.38
	Gg12	1.07	26.75	-3.99
ESSFdk1	Gb	0.00	6.21	0.00
	Gb20	6.78	23.30	-29.08
ESSFdkw	Gb20	2.89	25.38	-11.39
Total	Ga03$	0.00	1.87	0.00
	Gb	1.35	58.47	-2.31

BGC Unit	Grassland Ecosystem Class	Project Footprint Extent (ha)[1]	Landscapes and Ecosystems LSA Extent (ha)	Proportion of Change in Landscapes and Ecosystems LSA from Project Footprint (%)
	Gb04	0.36	58.41	-0.61
	Gb20	9.67	48.68	-19.86
	Gg	0.02	5.93	-0.38
	Gg12	1.07	26.75	-3.99
Total		12.47	200.11	-6.23

Note:
1. Based on the conservative assumption that all grassland ecosystem areas will be lost to make way for Project components.

The areas of Gb20 grasslands are located within the proposed South Pit and mine rock storage areas of the Project footprint. These areas will be affected during the Operations phase through the progressive clearing of pits and mine rock storage areas, resulting in a loss of 10 ha of Gb20 grasslands, which represents 20% of available Gb20 grasslands in the Landscapes and Ecosystems LSA. Although the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) includes the restoration of 181 ha of grassland ecosystems during the Reclamation and Closure phase, the degree of similarity to those removed ecosystems, or their functional value is uncertain.

Mitigation measures proposed are aimed at reducing direct impacts to grassland ecosystems as a result of Construction and Pre-Production and Operations activities. Prior to site disturbance, the Project footprint will be surveyed to confirm presence of grassland ecosystems adjacent to existing access roads and previously disturbed areas (Figure 13.6-2), particularly the Red-listed Gg12 ecological community. Where grassland areas overlap with the anticipated area of disturbance, areas will be flagged and quantified to establish "no-work", where possible, and establish potential areas for monitoring and data collection. Given past disturbance and current use of access roads in the Project footprint, the abundance of grasslands along existing linear infrastructure may be less than the anticipated area of direct loss identified in the Project effects assessment.

Change in Grassland Composition and Structure due to Vegetation Removal and Soil Disturbance

The indirect alteration of grassland ecosystems within an area of influence around the Project footprint represents a residual effect as a result of vegetation removal and soil disturbance within the Project footprint. Vegetation removal and soil disturbance within the Project footprint may indirectly alter the conditions of grasslands adjacent to site disturbance and result in the loss or alteration of the biological soil crust, create conditions conducive to forest encroachment, increase potential for soil erosion, alter the plant species assemblages and community structure, and alter the ecological community's ability to recover from disturbance. Grasslands, such as the Red-listed Gg12 ecological community, can be slow to recover from disturbance. In addition, grassland ecosystems can be vulnerable to disturbance when their soils are affected (B.C. CDC, 2018b).

Biological soil crusts provide a variety of functions, such as supporting water infiltration to soil, protecting soil from erosion, and contributing carbon and nitrogen to soil (Rosentreter et al., 2007). As such, changes to soil conditions, whether through soil and biological crust removal, or compaction of soils within grassland ecosystems, may adversely affect the biological crust function and distribution. MacKillop et al.

(2018) note that biological soil crusts are highly sensitive and very slow to re-establish following disturbance.

No listed plant populations were documented within the Project footprint. Residual adverse effects to listed plant populations are therefore not anticipated, as no changes in habitat suitability for the observed listed plant species will occur as a result of Project activities.

It is anticipated that effects on grassland composition and structure in regards to invasive plants will be completely mitigated and will not result in a residual effect.

13.6.4.3.3 Characterization of Residual Effects

Change in Grassland Abundance and Distribution

The residual effect of a change in grassland abundance and distribution due to clearing, grubbing, and soil salvaging is characterized as follows:

- Duration: Long-Term to Permanent, as the direct loss of grasslands will occur in the Construction and Pre-Production and Operations phases, and will last until the Post-Closure phase as grasslands are restored in the Project footprint through the reclamation activities.
- Magnitude: Moderate, as there will be an overall 6% loss of grassland ecosystems within Landscapes and Ecosystems LSA due to development of the Project footprint.
- Geographic Extent: Discrete, as only grasslands within the Project footprint will be directly impacted and lost.
- Frequency: Once, the direct loss of grassland ecosystems within the Project footprint occurs only once within the Construction and Pre-Production and Operations phases of the Project.
- Reversibility: Reversible Long-Term to Irreversible, although reclamation activities will restore 181 ha of grassland ecosystems, it is unlikely that the pre-construction functional value of all areas will be restored to the same level.
- Context: Low, grasslands affected by Project development have a low sensitivity and resilience to change as they are anticipated to be slow to recover from disturbance.

Determination of Significance

The residual environmental effect of the Project on a change in grassland abundance and distribution is considered not significant. Project effects to grassland geographic extent are limited to the extent of the Project footprint, in which 12 ha of grassland ecosystems are affected overall. This represents an overall loss of 6% of grasslands within the Landscapes and Ecosystems LSA. The Project is not expected to result in considerable changes to grassland ecosystem measurement indicators of ecosystem abundance and distribution. Further, 181 ha of grasslands will be restored in the Project footprint during Reclamation and Closure.

Project effects to the Gg12 ecological community, a provincially Red-listed ecological community, are limited in extent and discrete in nature, in which 1 ha will be directly affected. The direct impact to the Gg12 ecological community represents a permanent loss of 4% of the ecological community within the Landscapes and Ecosystems LSA. Given that the overlap of the Project with the Gg12 ecological community occurs within areas of previous disturbance (e.g., informal local access roads and a rail line) and that less area of Gg12 grassland may actually occur within the Project footprint than the TEM indicates, the loss of 1 ha of Gg12 is not anticipated to affect or reduce the community's long-term survival in the East Kootenay. Any indirect effects that could occur to the listed Gg12 plant community outside the Project footprint (e.g., from dust deposition, invasive plants) would be determined from follow-up and monitoring, and adaptive management measures to implement corrective actions would be developed as necessary based on that follow-up. Therefore, in consideration of the above, the Project design to avoid impacts to grasslands as much as possible, and planned mitigation measures, the residual effect of the Project on grassland ecosystem abundance and distribution during all phases of the Project is rated not significant.

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 grassland abundance and distribution from Project development is considered to be moderate. While baseline conditions of grassland ecosystems within the Project footprint are well established and understood, uncertainty exists with respect to the extent and distribution of grasslands adjacent to existing areas of disturbance and linear features that currently bisect the ecosystems. Available data allow for an understanding of potential effects to grassland ecosystems; however, additional data may support a better understanding of the interactions between the Project and the grasslands ecosystem VC.

Change in Grassland Composition and Structure due to Vegetation Removal and Soil Disturbance

The residual effect associated with a change in grassland composition and structure due to vegetation removal and soil disturbance is characterized as follows:

- Duration: Long-term, as grassland ecosystems and associated biological soil crust (where present) may be slow to re-establish if indirectly impacted as a result of site disturbance within the Project footprint.
- Magnitude: Low to Moderate, as changes to grassland composition and structure adjacent to the Project footprint may range from undetectable change at a microclimatic scale that is challenging to quantify to detectible and quantifiable alteration in the grassland composition and structure as a result of disturbance within the Project footprint.
- Geographic Extent: Local, as indirect alteration of grasslands may occur within an area of influence adjacent to and outside of the Project footprint.
- Frequency: Once, the potential alteration and indirect effects caused by vegetation removal and soil disturbance will only occur once to each grassland area during the Construction and Pre-Production and Operations phases of the Project.
- Reversibility: Reversible Long-Term, as the indirect effects of vegetation removal and soil compaction will cease after the Construction and Pre-Production and Operations phases and affected areas will be reclaimed and revegetated, should alteration of the ecological community occur outside of the Project footprint.
- Context: Low, grassland ecological features, such as biological soil crusts, have a low sensitivity and resilience to change, and recovery from disturbance is anticipated to be slow.

Determination of Significance

The residual effect on grassland composition and structure due to vegetation removal and soil disturbance is considered not significant. The indirect alteration of grassland ecosystems adjacent to the Project footprint is not expected to result in an alteration of ecosystem composition and structure that would pose a risk to the long-term viability and persistence of grassland ecosystems in the Landscapes and Ecosystems RSA, or result in direct mortality of an individual listed plant species or ecological community such that the likelihood for long-term survival of the listed plant population or ecological community in the East Kootenay is reduced. Indirect effects on grassland composition and structure, including the biological soil crust, adjacent to the Project footprint will be monitored over the course of the Construction and Pre-Production and Operations phases to evaluate changes in the ecosystem composition and structure. Further, areas that are anticipated to have been indirectly affected by Project footprint disturbance will be restored with appropriate native vegetation species and conditions conducive to the re-establishment of biological soil crust.

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 grassland ecosystem composition and structure from vegetation removal and soil disturbance is considered to be moderate. Based on existing disturbance on grasslands within and adjacent to the Project footprint and use of existing local access roads for Project development, the extent of grasslands and observed biological soil crust adjacent to the proposed Project footprint and existing linear features, the extent of some grasslands (particularly the Red-listed Gg12 ecological community) immediately adjacent to existing linear features may be less than anticipated. Available data allow for an understanding of potential effects to grassland ecosystems; however, additional data may support a better understanding of the interactions between the Project and the grassland ecosystems VC.

13.6.4.3.4 Summary of Residual Effects Assessment

Residual effects and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 13.6-8. There are no significant residual effects to grassland ecosystems anticipated as a result of the Project.

13.6.5 Project Effects on Riparian Habitat

13.6.5.1 Discussion of Potential Effects

In general, the Project has the potential to affect riparian habitat through reduction of ecosystem abundance and alteration of ecosystem composition and structure.

Reduction of ecosystem abundance is predicted to occur during the Construction and Pre-Production phase of development through logging, clearing, and grubbing. Reduction of riparian habitat is specifically anticipated to occur along improvements to existing roads (e.g., Grave Creek Road), new access roads, the rail loadout, service corridors, Grave Creek Reservoir, explosive storage facility, mined areas, mine rock storage areas, and the Main Sediment Pond (including associated components). Cumulatively, the

Table 13.6-8: Summary of Residual Effects on Grassland Ecosystems

Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Change in Grassland Abundance and Distribution	• Construction and Pre-Production • Operations • Reclamation and Closure	• Project design optimization • Minimizing disturbance and cleared areas • Establish exclusion / "no work" zones and setback buffers • Education and training • Implementation of the Soil Management Plan and the Erosion and Sediment Control Plan • Implement the Vegetation and Ecosystems Management and Monitoring Plan and the Ecological Restoration Plan	Duration: Long-Term to Permanent Magnitude: Moderate Geographic Extent: Discrete Frequency: Once Reversibility: Reversible Long-Term to Irreversible Context: Low	Not Significant	Moderate
Change in Grassland Composition and Structure due to Vegetation Removal and Soil Disturbance	• Construction and Pre-Production • Operations • Reclamation and Closure	• Project design optimization • Establish exclusion / "no work" zones and setback buffers • Minimizing disturbance and cleared areas • Retain vegetation and groundcover • Restore with appropriate native vegetation • Adhere to least risk windows • Minimize soil compaction • Implementation of Soil Management Plan • Implementation of Erosion and Sediment Control Plan • Implement the Vegetation and Ecosystems Management and Monitoring Plan and the Ecological Restoration Plan • Education and training • Monitor changes in plant community and areas of revegetation	Duration: Long-Term Magnitude: Low to Moderate Geographic Extent: Local Frequency: Once Reversibility: Reversible Long-Term Context: Low	Not Significant	Moderate

total area of riparian habitat to be removed as a direct overlap with components of the Project footprint is 78.39 ha, comprising, 6% of the Project footprint, or 7% of the riparian habitat within the Landscapes and Ecosystems LSA. Although much of the Project footprint will be developed during the initial phase of development, similar activities are anticipated to be conducted as part of incremental expansion within the approved limits of the Project during latter periods of operations.

Alteration of ecosystem composition and structure is predicted to occur through dust and sediment inputs, changes in surface water quantity, as well as the introduction and/or spread of invasive species, as follows:

- Reduction of ecosystem abundance and distribution through logging, clearing, grubbing, and soil salvage, as well as through reduced surface water quantity; and
- Alteration of composition and structural changes through dust and sediment inputs, changes in surface water quantity and quality, and introduction and/or spread of non-native invasive species through operation of vehicles and equipment in the Project footprint.

Potential effects on riparian habitat due to the Project that are carried forward in the discussion of potential effects are identified in Table 13.6-9 and discussed in the context of each Project phase below.

Table 13.6-9: Project Effects for Riparian Habitat

Potential Effect	Rationale for Selection of Environmental Effect
Change in Abundance and Distribution of Riparian Habitat	Where overlapping with the Project footprint, logging, clearing, and grubbing of vegetation, and removal of soil and overburden, will necessarily remove areas of riparian habitat within the Project footprint. Project activities relating to the diversion and retention of water, as well as the management of discharge from the Main Sediment Pond, have potential to reduce the quantity of surface water conveyed in West Alexander Creek (and downstream Alexander Creek) and Grave Creek. Given the dependence of riparian habitats on elevated water levels, reduced water quantity can result in permanent change to the soil moisture regime, facilitating incursion of species favouring drier conditions. Complete shift of the vegetation community to a dominance of species favouring drier conditions would constitute a reduction in the total area of riparian habitat.
Change in Composition and Structure of Riparian Habitat	Deposited sediments (whether suspended in water or air) or deleterious substances have potential to disrupt plant physiological processes (e.g., evapotranspiration, nutrient uptake), causing reduced vigour of existing vegetation that may result in a loss of cover or entire species within the affected riparian area. Reduced vegetation cover, or loss of whole species, may increase susceptibility of riparian habitats to erosion and/or incursion of invasive species. Consequently, erosion and suspension of exposed soils, construction material (e.g., road fill), stockpiled coal and mine waste (e.g., mine rock), or release of deleterious substances due to leaks, spills, or the transport, handling, and/or use of hazardous materials (e.g., ammonium nitrate) have the potential to affect the composition and structure of vegetation in riparian habitats. Given the dependence of riparian habitats on elevated water levels, reduced water quantity can result in permanent change to the soil moisture regime of riparian habitats, facilitating incursion of species favouring drier conditions, or invasive species. Project activities relating to the diversion and retention of water, as well as

Potential Effect	Rationale for Selection of Environmental Effect
	the management of discharge from the Main Sediment Pond, have potential to reduce the quantity of surface water conveyed in West Alexander Creek (and downstream Alexander Creek) and Grave Creek, and therefore have the potential to affect the composition and structure of vegetation in riparian habitats. Finally, as they have evolved outside the context of the local native vegetation communities and typically reproduce or spread at substantially higher rates than native vegetation species, non-native or invasive species typically have a competitive advantage over native vegetation, even using chemical deterrents to further restrict the growth of desirable native vegetation. The potential occurrence of naturally exposed substrates from the erosive potential of watercourses that meander through or adjacent to riparian habitats, as well as the capacity for watercourses to suspend and deposit seeds, bulbs, or other reproductive non-native and invasive vegetation material can result in the spread of invasive plants into riparian habitats. Given that the Project has potential to introduce non-native and invasive species to adjacent (avoided) riparian habitats, and that the Project has potential to alter the ecological conditions within downstream/downwind riparian habitats, the Project has the potential to introduce and/or spread non-native and invasive species that may adversely affect the vegetation composition and structure of riparian habitats.

13.6.5.1.1 Change in Abundance and Distribution of Riparian Habitat

Construction and Pre-Production

Potential effects on the abundance and distribution of riparian habitats are anticipated in the Construction and Pre-Production phase of Project development. Logging of merchantable timber, clearing and grubbing of vegetation, stockpiling soil, and diversion of retained waterbodies associated with construction of the Project footprint will directly remove or alter the hydrological inputs, terrain features, and associated environmental components (i.e., soil and vegetation) upon which riparian habitats are defined.

Alteration of water quantity in downstream reaches of affected watersheds has potential to reduce the area of riparian habitat, particularly where the magnitude of change in surface water quantity is high. This includes areas of riparian habitat within the lower reaches of the West Alexander Creek watershed, where mean monthly and annual flows are anticipated to experience a net reduction of between 9% and 40% (Chapter 10). Given the dependence of riparian habitats on elevated water levels, reduced water quantity can result in permanent change to the soil moisture regime, facilitating incursion of species favouring drier conditions. Complete shift of the vegetation community to a dominance of species favouring drier conditions would constitute a reduction in the total area of riparian habitat. Although a substantial change in flow rates is anticipated, uncertainty in the vegetation response prevents the quantification of the extent and magnitude of the loss of riparian habitat due to a reduction in water quantity.

Further downstream (i.e., middle and lower reaches of the Alexander Creek watershed), mean monthly and mean annual flows are anticipated to exhibit moderate reduction (i.e., less than 15% change). This is not likely to affect the abundance and distribution habitat, but rather will affect the composition and structure of retained riparian habitats downstream from the Project. Alteration of water quantity in downstream reaches of Grave Creek are anticipated to be low (Chapter 10), and therefore associated reduction in the extent of riparian habitat is not anticipated.

Operations

Potential effects to the abundance and distribution of riparian habitats are anticipated during the Operations phase, attributed to the construction and expansion of pits, the Mine Rock Storage Facility, and construction of the Main Sediment Pond (Figure 13.6-3). The total area of loss of riparian habitat attributed to the Operations phase was included within the maximum potential extent of the Project footprint overlapping with areas of riparian habitat (i.e., 78.39 ha).

Reclamation and Closure

Ecological restoration will be conducted during the Reclamation and Closure phase, during which abiotic conditions (e.g., surface contours, drainage pathways) and early successional trajectories of vegetation communities will be established in accordance with the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3). With successful implementation, the restoration of ecological conditions will partially reverse the loss of riparian habitats in the Project footprint.

Post-Closure

Potential effects on riparian abundance and distribution are not anticipated during Post-Closure beyond those that occurred in the Construction and Pre-Production and Operations phases.

13.6.5.1.2 Change in Composition and Structure of Riparian Habitat

Construction and Pre-Production

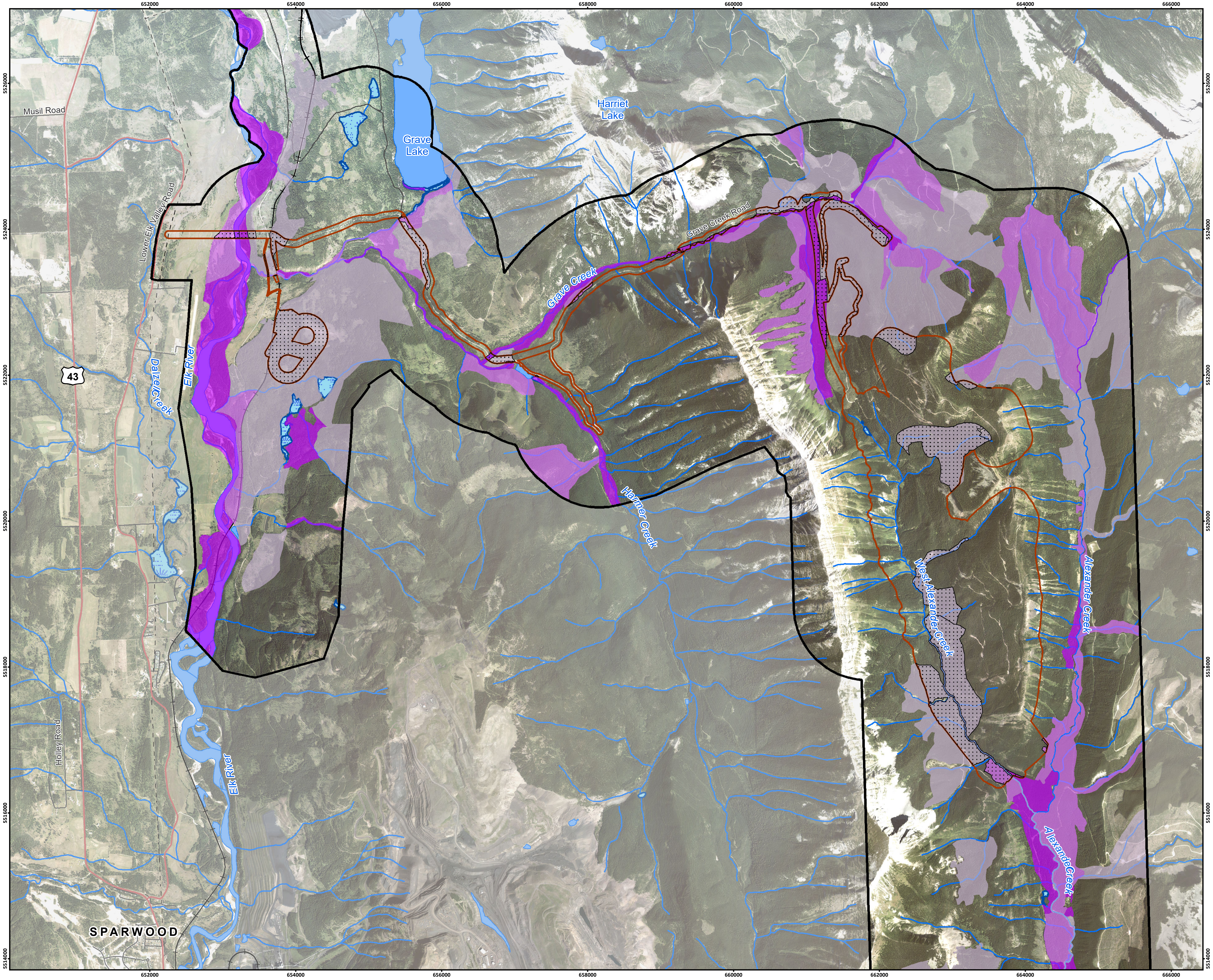
Potential effects to the composition and structure of riparian habitats are anticipated during the Construction and Pre-Production Phase. There is potential for the operation of vehicles and equipment to result in the introduction of new occurrences, or the spread of existing occurrences, of non-native and invasive species. Further, operation of vehicles and equipment within the Project footprint, as well as the hauling and use of hazardous materials, have the potential for release of deleterious substances to surface water (Chapter 21). Finally, the erosion and suspension of exposed soils and construction material (e.g., road fill) can result in sedimentation of, or deposition of, dust in riparian habitats downstream/downwind from the Project footprint. These sources of deleterious substances and deposited sediments/dust have potential to disrupt plant physiological processes (e.g., evapotranspiration, nutrient uptake), causing reduced vigour of existing vegetation. A reduction in plant vigour may result in a loss of vegetation cover or entire species within affected riparian habitat, increasing susceptibility to erosion and/or incursion of invasive species that typically occupy disturbed or otherwise non-vegetated areas.

Project activities relating to the diversion and retention of water, as well as the management of discharge from the Main Sediment Pond, have potential to reduce the quantity of surface water conveyed in West Alexander Creek (and downstream Alexander Creek) and Grave Creek. Given the dependence of riparian habitats on elevated water levels, reduced water quantity can result in permanent change to the soil moisture regime, facilitating incursion of species favouring drier conditions, or invasive species.

Given the potential occurrence of naturally exposed substrates from the erosive potential of watercourses, and the capacity for watercourses to suspend and deposit seeds, bulbs, or other reproductive vegetation material from existing occurrences, riparian habitats may be susceptible to incursion by non-native and invasive species introduced from outside the Project footprint. As they have

Crown Mountain Coking Coal Project

Figure 13.6-3
Riparian Habitat Loss



LEGEND

- Riparian Habitat Loss
- Riparian Habitat (Dominant)
- Riparian Habitat (Codominant)
- Riparian Habitat (Subdominant)
- Landscapes and Ecosystems Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- British Columbia/Alberta Border

0 1 2
Kilometres

N W E S

Scale 1:50,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, 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: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

Project: 12-6231
Status: FINAL
Date: 2022-01-11

Document Path: \\42dillon\CAD\GIS\2012 and Prior\126231 Crown Mountain\EA_Report\EffectsAssessment\Terrestrial\126231_EA_TErp_RiparianHabitatLoss.mxd evolved outside the context of the local native vegetation communities and typically reproduce or spread at substantially higher rates than local species, non-native or invasive species typically have a competitive advantage over native vegetation. Some non-native and invasive species even release chemicals (e.g., knapweeds [Centaurea spp.]) to further restrict the growth of desirable native vegetation.

Collectively, these sources of non-native and invasive species, environmental impairment, and altered water flows, together with an inherent susceptibility to incursion of non-native and invasive species, have potential to result in alteration of the composition and structure of riparian habitats downstream and/or downwind of the Project footprint. Although these sources of impact may possibly occur frequently and endure for a prolonged period in some locations, uncertainty in the vegetation response precludes the ability to quantify the extent and magnitude of change in the composition and structure of riparian habitat.

Operations

Potential effects to the composition and structure of riparian habitat are anticipated during the Operations phase. For the same reasons provided for the Construction and Pre-Production phase, the Operations phase has potential to result in change to the composition and structure of riparian habitat.

Reclamation and Closure

Assuming that all releases of deleterious substances were, or can be remediated and/or removed for disposal during the Reclamation and Closure phase, then changes to the composition and structure of riparian habitats associated with the release of deleterious substances is not likely to occur during the Reclamation and Closure phase.

If revegetation is not completely successful, then erosion and sedimentation of, or deposition of dust to riparian habitats located downstream or downwind of the Project footprint may continue to occur. For the same reasons provided for the Construction and Pre-Production phase, the Reclamation and Closure phase has potential to result in change to the composition and structure of riparian habitat caused by erosion and sedimentation or deposition of dust.

Post-Closure

If revegetation is not completely successful, then erosion and sedimentation of, or deposition of dust to riparian habitats located downstream or downwind of the Project footprint may continue to occur. For the same reasons provided for the Construction and Pre-Production phase, the Post-Closure phase has potential to result in change to the composition and structure of riparian habitat caused by erosion and sedimentation or deposition of dust.

13.6.5.1.3 Transboundary Effects

Watercourses within the Landscapes and Ecosystems LSA drain to the Elk River, and Lake Koocanusa, a transboundary waterbody. As described in Section 13.6.3.1.3, the Project is located approximately 5 km west of the Alberta border, approximately 85 km north of the Montana border, and does not overlap with federal lands. The atmospheric environment assessment (Chapter 6, Section 6.5.4.2.1) concluded that no measureable transboundary effects on air quality in the United States, Alberta, or on federal lands are anticipated to occur as a result of the Project. As such, no transboundary effects to riparian habitat as they relate to fugitive dust or changes in air quality are anticipated to occur. Given the proximity of the Project to international borders and that all watersheds within and surrounding the Project footprint are located on the western side of the Continental Divide, it is unlikely transboundary riparian habitat will be impacted by sediments, deleterious substances, and/or non-native and invasive species dispersed from the Project to riparian habitat in the United States or Alberta. As described in Chapter 11, Section 11.5.2.3, changes to surface water quality within the Dominion Coal Blocks located approximately 20 and 40 km southwest of the Project are not anticipated to occur; therefore, effects to riparian habitat on federal lands are not anticipated.

13.6.5.2 Mitigation Measures

The mitigation measures proposed for riparian habitat are based on available BMPs, guidance documents, mitigation measures conducted 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 (B.C. MOE, 2014a and B.C. MOE, 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 riparian habitat. For the purposes of this assessment, mitigation measures are defined to include Project design features, procedures, or practices that are intended to reduce or eliminate Project-related effects to riparian habitat. Potential Project-related changes to riparian habitat will be reduced through design mitigation, adherence to regulatory requirements, and BMPs, including management plans, monitoring, and adaptive management. Where mitigation measures are considered completely effective, potential Project effects to riparian habitat are not identified as residual effects.

The following subsections describe measures to mitigate the potential Project effects on riparian habitat, including those for a change in abundance and distribution and a change in composition and structure.

13.6.5.2.1 Mitigation Measures for Change in Abundance and Distribution of Riparian Habitat

Logging, Clearing, Grubbing, and Soil Salvage

Riparian habitat has the potential to be affected through site clearing and grubbing activities, and the removal of vegetation and soil. Where avoidance of riparian habitat within the Project footprint is not possible, additional mitigation measures have been provided to minimize the severity, or geographic or temporal extent of the potential effects. As part of the Reclamation and Closure phase, riparian habitat will be restored within the Project footprint through implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3).

To mitigate the change in abundance and distribution of riparian habitat within the Project footprint over the course of the Project, the following mitigation measures will be implemented:

- Minimize disturbance and encroachment into riparian habitats, to the extent feasible, by clearing and grubbing only what is required for Construction and Pre-Production activities and development of the Project;

- Implement the Soil Management Plan (Chapter 33, Section 33.4.1.9) to salvage and stockpile soils from riparian habitats removed during the Construction phase for future reclamation activities;
- Implement the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1) and the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4) to reduce indirect impacts to downwind and downstream of riparian habitats; and
- Monitor reclaimed areas to evaluate effectiveness of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) in meeting compensation goals and objectives.

Information collected as part of follow-up to the management plans (Chapter 33) will be used to inform success of reclamation and compensation strategies and determine, if necessary, the implementation of appropriate adaptive management strategies to achieve replacement of riparian habitat.

Changes to Surface Water Quantity

Riparian habitat downstream from the Project footprint has potential to be affected by changes in surface water quantity by diversion, storage, and use of water during the Construction and Pre-Production and Operations phases of the Project. All water shall be managed in accordance with the Fish and Fish Habitat Management Plan (Chapter 33, Section 33.4.1.5) and the Site Water Management Plan (Chapter 33, Section 33.4.1.8). Specific mitigation measures to reduce the potential for adverse effects to riparian habitat abundance as a result of changes to surface water quantity include:

- Limit the mine disturbance footprint and avoiding affecting additional drainages beyond West Alexander and Grave Creeks;
- Develop all surface water management infrastructure in accordance with standard industry practice; and
- Incorporate energy dissipation devices, structures, or other related armouring techniques to maintain the frequency and magnitude (e.g., rate of flow) of discharge events within the range of natural variation for the West Alexander Creek and Grave Creek watersheds, where feasible.

13.6.5.2.2 Mitigation Measures for Change in Composition and Structure of Riparian Habitat

Erosion, Sedimentation/Deposition of Dust, and Release of Deleterious Substances

Construction and operational activities have the potential to erode soils and cause sedimentation, or release a deleterious substance to downslope areas of riparian habitat. Deposited sediments or other deleterious substances may interfere with plant physiological processes that affect the vigour of, and subsequently the diversity and dominance of, desirable, native vegetation. In turn, this increases the susceptibility of riparian habitats to incursion by non-native and invasive species. The measures provided in the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1), the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4), the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11), the Soil Management Plan (Chapter 33, Section 33.4.1.9), the Spill Prevention, Control and Countermeasures Plan (Chapter 33, Section 33.4.1.10) and the Site Water Management Plan (Chapter 33, Section 33.4.1.8) will be implemented over the course of the Project. Mitigation measures to be implemented include but are not limited to:

- Enforcement of low speed limits for vehicular traffic throughout the site, such as along Grave Creek Road, to minimize dust;

- Maintain unpaved roads and keep in good repair, including regular road compaction and use of coarse aggregate with low silt content, where possible;
- Conduct earthmoving activities in a manner that reduces exposed soils and avoids dust-generating activities during windy periods, where possible;
- Spray water or use other dust suppression methods during dry periods from May to November to mitigate dust generation in areas including unpaved roads and work areas. 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;
- Install equipment covers, and using dust hoods and shields at the rail loadout;
- Locate soil stockpiles at appropriate locations far from riparian habitat, and store and shape in ways to allow for slope stability and reduce moisture content loss, including establishment of vegetation to reduce exposure to wind and water erosion;
- Use progressive reclamation and revegetation throughout the mine life to minimize wind erosion potential and reduce the Project footprint;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to riparian habitat;
- Monitor and inspect air quality and dust control measures to confirm they are effective and functioning properly, which will allow for timely maintenance and adjustments as required.
- Minimize the extent of disturbance within riparian habitats to the smallest area necessary;
- Limit exposed soils near riparian habitats to reduce the potential for erosion and sedimentation;
- Incorporate energy dissipation devices, structures, or other related armouring techniques to maintain the frequency and magnitude (e.g., rate of flow) of discharge events within the range of natural variation for the West Alexander Creek and Grave Creek watersheds, where feasible;
- Monitor water quality downstream of the Project footprint to evaluate changes in water quality as per the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4); and
- Conduct regular inspections of control measures established to address erosion and sedimentation and complete necessary repairs in a timely manner to protect wetland ecosystems.

Changes in Surface Water Quantity

Riparian habitat downstream from the Project footprint has potential to be affected by changes in surface water quantity by diversion, storage, and use of water during the Construction and Pre-Production and Operations phases of the Project. All water shall be managed in accordance with the Fish and Fish Habitat Management Plan (Chapter 33, Section 33.4.1.5) and the Site Water Management Plan (Chapter 33, Section 33.4.1.8). Specific mitigation measures to reduce the potential for adverse effects to riparian habitat abundance as a result of changes to surface water quantity include:

- Limit the mine disturbance footprint and avoiding affecting additional drainages beyond West Alexander and Grave Creeks;
- Develop all surface water management infrastructure in accordance with standard industry practice; and
- Incorporate energy dissipation devices, structures, or other related armouring techniques to maintain the frequency and magnitude (e.g., rate of flow) of discharge events within the range of natural variation for the West Alexander Creek and Grave Creek watersheds, where feasible.

Invasive Plant Species

Given the potential occurrence of naturally exposed substrates from the erosive potential of watercourses, and the capacity for watercourses to suspend and deposit seeds, bulbs, or other reproductive vegetation material from existing occurrences, riparian habitats may be susceptible to incursion by non-native and invasive species introduced from outside the Project footprint. As they have evolved outside the context of the local native vegetation communities and typically reproduce or spread at substantially higher rates than local species, non-native or invasive species typically have a competitive advantage over native vegetation.

All mine construction, operation, and reclamation activities requiring ground disturbance and/or removal of vegetation may result in the introduction or spread of non-native and invasive species. Implementation of the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11) and specific measures to control and eradicate invasive plants is integral to protecting riparian habitats.

Prior to construction, it is anticipated that a Project-specific management plan for invasive plants will be developed as an operational guide to manage invasive plants within the Project footprint and be implemented across the footprint over the course of the Project to control existing and future invasive plant populations.

Measures to control existing invasive plant populations and reduce the potential for the introduction of additional invasive plants in Construction and Pre-Production, Operations, and Reclamation and Closure include:

- Identify and demarcate invasive plant populations around riparian habitats prior to construction;
- Establish setback areas and "no-work" areas if invasive plant populations are located near riparian habitats to reduce the spread of invasive plants by machinery and vehicles;
- Remove existing invasive plant populations to prevent the spread to adjacent areas;
- Undertake invasive control activities, including distribution of biocontrol agents, and mechanical and chemical treatments;
- Reduce exposure of bare ground near riparian habitats;
- Restore sites with native vegetation species following treatment of invasive infestations and ground disturbance to establish vegetative cover;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to riparian habitats;
- Restrict vehicle and machinery traffic to designated access roads; and
- Apply contouring and erosion control measures to limit spread of invasive and agronomic species seed and plants.

Additional mitigation measures related to invasive species management are provided in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

13.6.5.2.3 Summary of Mitigation Measures for Riparian Habitat

The key mitigation measures proposed to mitigate potential effects on riparian habitats are summarized in Table 13.6-10. This table also identifies the anticipated residual effects that will be carried forward in the characterization of residual effects, significance, and likelihood and confidence.

Table 13.6-10: Summary of Proposed Mitigation Measures Related to Riparian Habitat

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Abundance and Distribution of Riparian Habitat	• Project design optimization • Implementation of Ecological Restoration Plan • Minimizing disturbance and cleared areas • Monitor reclaimed riparian habitat function • Project design optimization • Design standards for water management infrastructure • Energy dissipation devices	• Measures contribute to the avoidance, minimization, and restoration of riparian habitat losses associated with construction, mining, and operational management activities. • Effects of Project development on the riparian habitat extent are not expected to be fully mitigated.	• Construction and Pre-Production • Operations • Reclamation and Closure	Low	Yes
Change in Composition and Structure of Riparian Habitat	<u>Erosion, Sedimentation/Deposition of Dust, and Release of Deleterious Substances</u> • Implement the Air Quality and Greenhouse Gas Management Plan, the Soil Management Plan, the Erosion and Sediment Control Plan, the Vegetation and Ecosystems Management and Monitoring Plan, the Spill Prevention, Control and Countermeasures Plan, and the Site Water Management Plan. • Minimize the extent of disturbance within riparian habitats • Limit exposed soils near riparian habitats	• Recommended measures will contribute to the minimization of Project effects on riparian habitat composition and structure. • Effects of erosion, sedimentation/deposition of dust, and release of deleterious substances in riparian habitat are expected to be effectively mitigated such that a residual effect does not occur. • Effects on the composition and structure of riparian habitats as a result of changes to	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	Moderate	Yes

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	• Incorporate energy dissipation devices, structures, or other related armouring techniques. • Monitor water quality • Inspect erosion and sediment control measures • Education and training • Low speed limits • Regular road maintenance • Minimize earthworks during windy periods • Progressive reclamation and revegetation • Dust suppression methods. • Proper covers/shielding where required • Education and training. • Monitor and inspect dust control measures <u>Surface Water Quantity</u> • Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices <u>Non-native and Invasive Species</u> • Implement the Vegetation and Ecosystems Management and Monitoring Plan • Control, manage, and remove invasive plants on site	surface water quantity are not expected to be fully mitigated. • Effects of invasive plants on riparian habitat are expected to be effectively mitigated such that a residual effect does not occur. • Although they will act to reduce changes in the duration and/or frequency of runoff during precipitation events, mitigation measures are not anticipated to completely mitigate potential effects on surface water quantity affecting the composition and structure of riparian habitats downstream from the Project.			

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	• Establish buffers and "no-work" zones where current infestations • Restore with appropriate native vegetation • Education and training • Restrict traffic in known infested areas • Decontaminate vehicles and machinery				

Proposed mitigation measures generally align with standard industry practice, are well understood, and proven to effectively reduce adverse effects on the abundance, distribution, composition, and structure of riparian habitat. As it is unlikely that optimization of project design and water discharge management in West Alexander Creek can completely avoid all effects to riparian habitat, confidence with the effectiveness of mitigation measures is considered low to moderate. Where mitigation measures do not or may not mitigate all effects or if there is a low 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.

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 Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

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

Based on the evaluation of potential Project effects on riparian habitat, potential residual effects that may remain after implementation of measures to avoid and minimize adverse effects include: change in riparian habitat abundance and distribution; and change in riparian habitat composition and structure as a result of changes in surface water quantity.

13.6.5.3.1 Assessment Methods

The characterization of residual effects follows methods outlined in Chapter 5, Section 5.3.4.5. Ecosystem-specific methods used in the assessment of residual effects are detailed below.

A footprint analysis was used to determine areas of the Project footprint that overlap and interact with riparian habitat. The maximum Project footprint extent, including clearing and contingency areas, presents the maximum extent of disturbance associated with the Project (as detailed by “Project footprint” boundary depicted in Figure 13.6-3).

Given the complexity of relationships among species and the abiotic environment, and that not all mechanisms of impact act equally in all locations at all times, characterization of changes in composition and structure was conducted qualitatively in consideration of industry best practices and the professional judgement of the authors.

13.6.5.3.2 Potential Residual Effects Assessment

Potential Project-related changes in the abundance and distribution of riparian habitat was predicted to occur, both directly from overlap with the Project footprint, and indirectly from changes in surface water quantity causing a shift of soil moisture regimes in retained, downstream areas. With the successful implementation of the recommended mitigation measures, the remaining potential effects on the composition and structure of riparian habitats from Project activities were predicted to be completely mitigated. The remaining potential effects were carried forward and a residual effects assessment is presented below.

Change in Abundance and Distribution of Riparian Habitat

The Project footprint has been designed in consideration of site-specific constraints, including specifications for design elements, available infrastructure (e.g., Grave Creek Road), environmental constraints, potential environmental effects, and the distribution of the mineable resource. The geographic extent and alignment of Project infrastructure has been designed to minimize the area of overlap between the Project footprint and riparian habitats to the greatest extent feasible, considering the technical and economic feasibility of avoidance, as well as other previously listed constraints on Project design. To ensure a geotechnically stable workspace that minimizes environmental and socio-economic effects while maximizing potential economic benefits, construction of the Project necessarily requires the clearing of riparian habitats in the Landscapes and Ecosystems LSA. Under a maximum potential impact scenario of development, whereby the Project is conservatively assumed to result in the direct loss of all the available riparian habitat present in the Project footprint, the Project is conservatively predicted to require the direct loss of up to 78.39 ha of riparian habitat (Table 13.5-14), equal to 7% of the total area of riparian habitat within the Landscapes and Ecosystems LSA.

In addition, an indirect loss of riparian habitat may occur outside of the Project footprint but within the Landscapes and Ecosystems LSA due to reductions in flow downstream of the Project footprint. Given their dependence on sub-irrigation from overland flooding and/or perched groundwater, riparian habitats subjected to prolonged or permanent drawdown and/or altered flow rates have potential to reduce in area where the change in frequency and/or duration of water inputs are of sufficient scale to reduce soil moisture content during the growing season. Sustained changes in soil moisture content over the growing season will favour incursion of species adapted to drier, upland conditions. Where the dominant constituent species comprising a riparian habitat have been replaced by upland adapted species favouring drier conditions, the area of riparian habitat is considered to have been lost.

Hydrologic modelling predicted that the Project has potential to reduce total flows in lower West Alexander Creek by up to 40%, gradually improving to less than 7% of the original flow at the lower extent of Alexander Creek, further downstream. Given the magnitude of change predicted to occur in lower West Alexander Creek, it is likely that adjacent riparian areas will reduce in area as a result of this drawdown; however, the proportional change in riparian habitat arising from this reduction in flow cannot be quantified as it is highly dependent on the timing and duration of flows, as well as site-specific substrate and topographic conditions and species-, population-, and community-specific responses. The extent of this indirect loss of riparian habitat in the Landscapes and Ecosystems LSA outside of the Project footprint cannot be quantified; however, a conservative estimate of the severity of impact to riparian areas in the West Alexander Creek watershed downstream of the Project is unlikely to represent a high magnitude loss of greater than 20% of riparian habitat available in the Landscapes and Ecosystems LSA, as established by Davidson et al (2018). Specifically, the extent of riparian habitat where the greatest change in water flows is anticipated (i.e., lower West Alexander Creek), is negligible in area (i.e., 14.84 hectares) relative to the total area of riparian habitat further downstream where changes in mean monthly and annual flows are much less (i.e., 453.39 hectares of riparian habitat downstream of the Project in the middle and lower Alexander Creek watershed).

Although implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) will establish the ecological conditions favourable for the development of riparian habitats, it is unlikely that all areas of riparian habitat will be completely replaced to the same extent or integrity as that observed under baseline conditions. Further, as alteration of water levels in the lower West Alexander Creek is anticipated to extend beyond the Post-Closure phase, it is unlikely that loss of riparian habitat due to drawdown of water levels will return to baseline conditions in the most severely affected circumstances. Consequently, it is predicted that a residual effect of a change in the abundance and distribution of riparian habitat will occur.

Change in Composition and Structure of Riparian Habitat

Changes in composition and structure of riparian habitat can occur through multiple mechanisms acting independently and/or cumulatively to reduce the vigour, and therefore the competitive ability of desirable vegetation. Where sufficient resources exist, other species may establish and compete with the riparian vegetation, or reduced vigour may result in greater areas of exposed soil, increasing the risk of erosion and bank instability. Through implementation of the provided environmental management plans and additional mitigation measures, changes in the composition and structure of riparian habitat can be effectively mitigated for those mechanisms attributed to erosion and sedimentation/deposition of dust, release of deleterious substances, and the introduction and/or spread of non-native and invasive species.

Where alteration of surface water quantity does not result in reduction or complete loss of riparian habitats, the composition of such communities may be altered with the incursion of adjacent upland species. Species adapted to the wetter, sub-irrigated conditions of riparian habitats may have a reduced competitive ability as water levels draw down in the lower reach of West Alexander Creek and middle reaches of Alexander Creek. Areas of riparian habitat along these reaches are likely to experience altered vigour of constituent species, resulting in a change in composition and/or structure of the vegetation community. Although still functioning as a riparian habitat ecosystem, alteration of water levels could, for example, increase the understorey growth of shrubby species, or eliminate hypoxic conditions that restricted growth of sub-canopy tree species. Where changes in water flows are anticipated to return to baseline conditions, vegetation composition and structure of riparian habitats may similarly return; however, the rate of return will depend on the type of vegetation affected. Given their faster rate of growth, herbaceous and shrubby species are anticipated to restore within 5 to 10 years following restoration of water levels. Restoration of tree species and associated coarse woody debris may take up to 140 years to restore, depending on the degree of change from baseline conditions. Restoration of a disclimax forest subjected to regular disturbance may take less time to restore when compared to a mature or old growth forest dominated by large diameter cottonwoods (Populus spp.).

Although implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) will establish the ecological conditions favourable for the development of riparian habitats, it is unlikely that all areas of riparian habitat will be completely replaced to the same extent or integrity as that observed under baseline conditions. Further, as alteration of water levels in lower West Alexander Creek is anticipated to extend beyond the Post-Closure phase, it is unlikely that loss of riparian habitat due to drawdown of water levels will return to baseline conditions in the most severely affected circumstances. Consequently, it is predicted that a residual effect of a change in the composition and structure of riparian habitat will occur.

13.6.5.3.3 Characterization of Residual Effects

Change in Abundance and Distribution of Riparian Habitat

The residual effect of the change in abundance and distribution of riparian habitat is characterized as follows:

- Duration: Long-term to Permanent. For those areas of riparian habitat that can be restored, reclamation is anticipated to occur throughout the Reclamation and Closure and potentially beyond the Post-Closure phases. All extents of the West Alexander Creek (including subsequent downstream segments of Alexander Creek) and Grave Creek will experience reduced water levels through to the end of, and likely beyond, the Post-Closure phase.
- Magnitude: Low, the loss of riparian habitat is small relative to the total area in Landscapes and Ecosystems LSA (i.e., 7%) and is less than the "low" benchmark established under the EV-CEMF (Davidson et al., 2018). The abundance and distribution of riparian habitat along middle and lower Alexander Creek and Grave Creek is not likely to detectably change, as the difference in flow rate from existing conditions is exceptionally low and within a reasonably assumed range of natural variation. Areas of substantially greater change in water flow rates of the retained lower West Alexander Creek are likely to noticeably reduce the extent of typical high water levels that define the riparian area (i.e., range of natural variation). Recruitment of adjacent upland vegetation in these areas is anticipated.
- Geographic Extent: Discrete to Regional, direct loss of riparian habitat will occur within the Project footprint, as well as indirectly due to reduced water flow rates that could marginally exceed the boundary of the Landscapes and Ecosystems LSA.
- Frequency: Once to Continuous, although general construction and subsequent mine expansion activities will be conducted throughout the Construction and Pre-Production and Operations Phases, removal of the riparian habitat at any location within the Project footprint can only happen once (i.e., when it is removed, it no longer exists). The loss of riparian habitat is anticipated to occur incrementally, and sequenced with timing of key milestones of Project construction in the respective catchment areas (e.g., complete isolation of the Project footprint) and seasonal precipitation cycles. Consequently, the residual effect is contemplated to occur regularly, or continuously throughout the Construction and Pre-Production and Operations phases of development.
- Reversibility: Reversible Long-Term to Irreversible, the effects of vegetation removal on riparian areas that are buried by by the Mine Rock Storage Facility cannot be reversed, nor where reduced flow rates are anticipated to extend beyond the Post-Closure phase. Where infrastructure is completely decommissioned (powerline and explosives storage area) and watercourse reclamation is successful, there is potential for effects to be reversible within the Post-Closure phase.
- Context: Neutral, although reduced in area, riparian habitats in the Landscapes and Ecosystems LSA are likely adapted to natural periods of disturbance. Pending successful restoration of contours and drainage profiles, riparian habitat is likely to restore using reasonably simple revegetation techniques (e.g., willow staking).

Determination of Significance

Using the thresholds for ranking the level of hazard associated with the extent of loss of riparian habitat provided by the EV-CEMF (Davidson et al., 2018), the reduction of riparian habitat associated with development of the Project footprint would be classified as a low risk.

Although the loss of riparian habitat due to changes in surface water quantity may extend beyond the Landscapes and Ecosystems LSA, the majority of the area affected is considered to be negligible relative to the total area of riparian habitat in the Landscapes and Ecosystems LSA. Collectively with removals due to logging, clearing, grubbing, and soil salvage activities, the loss of riparian habitat is considered to be of low magnitude, as the areas that cannot be successfully restored during the Reclamation and Closure phase are likely to be less than the EV-CEMF benchmarks used to define moderate to high risk of impact to riparian habitats (i.e., likely to be less than or equal to 10% loss). That said, as the assumed area of impact caused by the Project footprint has been based on conservatively assigned dimensions for each of the Project components, the final anticipated area of impact to riparian habitat is likely to be lower once site specific opportunities for avoidance can be investigated further during the detailed design stage of engineering. For those areas that cannot be avoided, and cannot be restored during the Post-Closure phase of the Project, the loss of riparian habitat will be permanent.

The loss of riparian habitat within the Landscapes and Ecosystems LSA is permanent and potentially irreversible; however, following implementation of the recommended mitigation measures, including applicable ecological restoration measures, the magnitude of the residual effect is considered to be low. Consequently, the residual effect associated with the adverse change in abundance (or area) of riparian habitat is considered to be not significant.

Likelihood and Confidence

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

Given that the exact areas of riparian habitat to be reclaimed have yet to be determined, and that some species may not respond in complete alignment with the assumptions of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3), there is only moderate confidence in the characterized extent and degree of success in the restoration of riparian habitats. As a result, the significance prediction is ascribed a moderate level of confidence; follow-up and monitoring may improve this level of confidence.

Follow-up monitoring will be conducted for the Post-Closure phase, during which any residual areas of riparian habitat not restored to a trajectory in alignment with baseline conditions will be evaluated in the certainty of their restoration status. Where residual areas of riparian habitat cannot be reclaimed to baseline conditions within the Project footprint, an equivalent area may be restored in the Landscapes and Ecosystems LSA, or a greater area elsewhere in the Landscapes and Ecosystems RSA, proportionately scaled according to the distance from the Project and the degree of restoration required. Specifically, the area to be restored shall increase with distance from the Project. Additionally, the level of restoration effort shall be inversely proportional to the area to be restored, relative to the area that was permanently impacted due to the Project. For example, if the area to be restored elsewhere in the Landscapes and Ecosystems RSA requires half the effort to restore to an equivalent baseline condition, then twice the area of impact shall be restored. All restoration of riparian habitat outside of the Project footprint shall be completed within the Post-Closure phase. The Post-Closure phase shall be extended until the satisfactory completion of restoration of all areas of impact to riparian habitat, whether inside the Project footprint or elsewhere in the Landscapes and Ecosystems RSA.

Change in Composition and Structure of Riparian Habitat

The residual effect of the change in composition and structure of riparian habitat is characterized as follows:

- **Duration:** Permanent, all extents of the West Alexander Creek (including subsequent downstream segments of Alexander Creek) and Grave Creek will experience reduced water levels through to the end of, and likely beyond, the Post-Closure phase. Impacts to the composition and structure of riparian habitat will cease upon restoration of water levels to within the range of natural variation experienced under baseline conditions.
- Magnitude: Low to High, the composition and structure of riparian habitat along middle and lower Alexander Creek and Grave Creek are not likely to detectably change, as the difference in flow rate from existing conditions is exceptionally low and within a reasonably assumed range of natural variation. Areas of substantially greater change in water flow rates of the retained lower West Alexander Creek are likely to noticeably reduce the extent of typical high water levels that define the riparian area (i.e., range of natural variation). Recruitment of adjacent upland vegetation in these areas is anticipated.
- Geographic Extent: Regional, extent of altered riparian habitat due to reduced water flow rates will marginally exceed the boundary of the Landscapes and Ecosystems LSA.
- Frequency: *Regular to Continuous*, given the seasonality of surface water conveyance and groundwater infiltration/discharge, alteration of the composition and structure of riparian habitat is anticipated to occur incrementally, and sequenced with timing of key milestones of Project construction in the respective catchment areas (e.g., complete isolation of the Project footprint) and seasonal precipitation cycles.
- Reversibility: Irreversible, the reduced flow rates in lower West Alexander Creek are anticipated to extend through to the end of, and likely beyond, the Post-Closure phase.
- Context: Neutral, riparian habitats in the Landscapes and Ecosystems LSA are composed of species generally adapted to natural periods of disturbance and therefore are likely to sustain where sufficient surface water quantity remains, and may adapt as natural climate cycles and weather patterns continue.

Determination of Significance

Although the alteration of the composition and structure of riparian habitat may be extensive (i.e., beyond the Landscapes and Ecosystems LSA), the majority of the area of impact is considered to be detectable but within the natural range of variation (i.e., low magnitude), and therefore the residual effect is considered to be not significant.

Likelihood and Confidence

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

In consideration that estimated change in water flow rates has a substantial range between forecasted low and high limits, there is moderate confidence in the extent of loss of riparian habitats downstream from the Project.

Follow-up monitoring will be conducted for the Post-Closure phase, and should include offsite monitoring elsewhere downstream of the Project along West Alexander Creek and Alexander Creek within the Landscapes and Ecosystems LSA. Any areas demonstrated to exhibit a permanent change in the composition and structure of riparian habitat within the Landscapes and Ecosystems LSA shall be included in the area to be restored, proportional to the degree of change caused and the area of vegetation indirectly affected by the Project.

13.6.5.3.4 Summary of Residual Effects Assessment

Residual effects for riparian habitats and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 13.6-11. Significant residual effects to riparian habitat are not anticipated as a result of the Project.

13.6.6 Project Effects on Old Growth and Mature Forest

13.6.6.1 Discussion of Potential Effects

In general, the Project has the potential to affect old growth and mature forest through:

- Reduction of ecosystem abundance and distribution through logging, clearing, and grubbing to make way for Project components; and
- Alteration of composition and structural changes through dust and sediment inputs, introduction of invasive species through transportation and widening of roads, and mining activities.

Interactions were not identified for Project activities relating to:

- Construction of buildings after clearing has occurred;
- Most activities related to water management;
- Stockpiling wood waste; and
- Most activities related to Reclamation and Closure and Post-Closure, with the exception of activities that generate dust.

Potential effects on old growth and mature forest as a result of the Project that are carried forward in the discussion of potential effects are summarized below in Table 13.6-12.

Table 13.6-11: Summary of Residual Effects on Riparian Habitat

Valued Component	Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Riparian Habitat	Change in Abundance and Distribution of Riparian Habitat	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Delay construction areas of mine components until ready to mine • Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices	Duration: Long-term to Permanent Magnitude: Low Geographic Extent: Discrete to Regional Frequency: Once to Continuous Reversibility: Reversible Long-Term to Irreversible Context: Neutral	Not Significant	Moderate
	Change in Composition and Structure of Riparian Habitat	• Construction and Pre-Production • Operations • Reclamation and Closure • Post-Closure	• Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices • Implementation of Soil Management Plan • Implementation of Erosion and the Sediment Control Plan • Implement the Vegetation and Ecosystems Management and Monitoring Plan and the Ecological Restoration Plan	Duration: Permanent Magnitude: Low to High Geographic Extent: Regional Frequency: Regular to Continuous Reversibility: Irreversible Context: Neutral	Not Significant	Moderate

Table 13.6-12: Potential Effects on Old Growth and Mature Forest

Potential Effect	Rationale for Selection of Environmental Effect
Change in Old Growth and Mature Forest Abundance and Distribution	Removal of vegetation through direct clearing in the Project footprint is a complete loss of old growth and mature forest.
Change in Old Growth and Mature Forest Composition and Vigour from Spread of Invasive Species and Dust Deposition	Increased vehicle traffic, stockpiling of salvaged soil, transportation of soil, and reclamation have the potential to introduce non-native species to old growth and mature forest. The increase in non-vegetated soil throughout the Project footprint during reclamation activities may lead to increased establishment of non-native plant species. Invasive species can result in the loss or alteration of vegetation and potentially affect species abundance.
	Project activities such as site clearing, construction, removal and movement of materials, detonating of explosives, maintenance, and long-term traffic may result in increased dust and deposition on vegetation, reducing vegetation vigour, potentially altering species composition and habitat value.

13.6.6.1.1 Change in Old Growth and Mature Forest Abundance and Distribution

Much of the Project footprint contains old growth and mature forest. Old growth and mature forest abundance and distribution will be permanently lost due to clearing and grubbing (up to 919 ha) of the Project footprint during Construction and Pre-Production and Operations.

Construction and Pre-Production

Clearing of old growth and mature forest will occur during the Construction and Pre-Production phase for construction of the rail loadout, road upgrades, preparation of the service corridor, the overland conveyor, mine site infrastructure and buildings and initial portions of pits and Mine Rock Storage Facility areas. The amount of old growth and mature forest lost in this phase will be approximately 250 ha, or 27% of the total amount to be cleared (Figure 13.6-4).

Operations

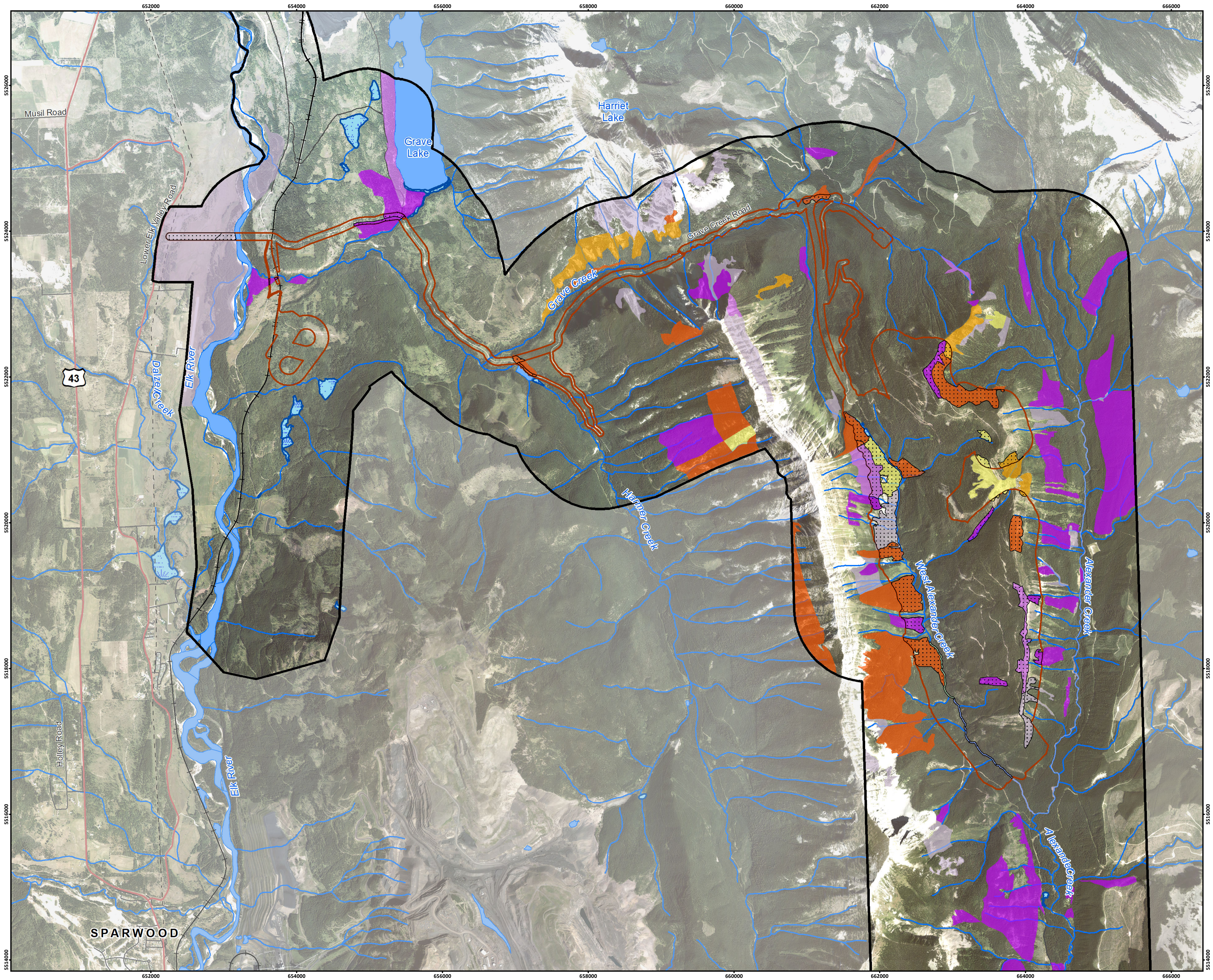
Clearing of old growth and mature forest will continue during Operations, with progressive clearing of pits and the Mine Rock Storage Facility areas. The remaining 669 ha expected to be lost (or less) will be progressively cleared over the 15 years of Operations.

Reclamation and Closure

No further loss of old growth and mature will occur during Reclamation and Closure.

Post-Closure

No further loss of old growth and mature will occur during Post-Closure.



Crown Mountain Coking Coal Project

Figure 13.6-4
Old Growth and Mature Forest Loss

LEGEND

- Old Growth and Mature Forest Ecosystem Loss
- Mature Forest (Structural Stage 6)
  - Mature Forest (Dominant)
  - Mature Forest (Codominant)
  - Mature Forest (Subdominant)
- Old Forest (Structural Stage 7)
  - Old Forest (Dominant)
  - Old Forest (Codominant)
  - Old Forest (Subdominant)
- Landscapes and Ecosystems Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- British Columbia/Alberta Border

0 1 2
Kilometres

N W E S

Scale 1:50,000

Map Drawing Information:
Data Provided By NWP Coal Canada Ltd, Dillon Consulting Limited, Keefer Ecological Services Ltd, Province of British Columbia GeoBC Open Data, Government of Alberta Open Data, Natural Resource Canada.
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13.6.6.1.2 Change in Old Growth and Mature Forest Composition and Vigour

Old growth and mature forest in the Project footprint that is not cleared (i.e., areas within the Project footprint that will be cleared in the future, or contingency areas that may not be cleared), or adjacent areas outside the Project footprint, may change in structure and composition from potential introduction and spread of invasive species and changes in vegetation vigour from dust deposition. Old growth and mature forest areas that are intended to be reclaimed to forest will not resemble pre-disturbance conditions for many decades.

Construction and Pre-Production

Potential effects on old growth and mature forest composition and structure are anticipated in the Construction and Pre-Production phase through transportation and clearing and grubbing activities. One effect of these Project activities may be increased dust generation, leading to increased deposition on vegetation in nearby forested areas. During the growing season, this may result in decreased plant vigour and a reduction in the palatability of the dust-covered vegetation to herbivores. Increased airborne particulate matter from dust can impact water and soil chemistry, which can have adverse effects on vegetation. Increased vehicle and machinery traffic can have adverse effects on old growth and mature forest composition and structure due to potential introduction or dispersal of invasive and agronomic plant species.

Operations

Potential effects to old growth and mature forest composition and structure are anticipated in the Operations phase through the loading, hauling, and stockpiling of soil and mine rock. Through the Operations phase, these activities may result in increased dust. As described above, dust deposition can have adverse effects on vegetation during growing season periods, through increased deposition and increased airborne particulate matter, and changes to soil and vegetation chemistry. Increased vehicle and machinery traffic can have adverse effects on old growth and mature forest composition and structure due to potential introduction or dispersal of invasive and agronomic plant species.

Reclamation and Closure

Potential effects to old growth and mature forest composition and structure are anticipated to be similar to those described for the Operations phase. Decreased site activities and fewer vehicles will result in less dust generation and lower potential for introduction of invasive and agronomic plant species.

Post-Closure

Permanent roads present the ongoing potential for the introduction of agronomic and invasive species in the Post-Closure phase. Ongoing traffic on these permanent features have the potential to introduce non-native species to intact and reclaimed habitats, which may invade adjacent forested areas. Invasion of agronomic species and weeds reduce habitat value of reclaimed areas.

13.6.6.1.3 Transboundary Effects

As described in Section 13.6.3.1.3, the Project is located approximately 5 km west of the Alberta border, approximately 85 km north of the Montana border, and does not overlap with federal lands. The most frequent wind direction recorded at the Project baseline climate station was from the southeast while the wind data recorded at the Sparwood CS station is predominant northerly and southerly. The atmospheric environment assessment (Chapter 6, Section 6.5.4.2.1) concluded that no measurable transboundary effects on air quality in Alberta, the United States, or on federal lands are anticipated to occur as a result of the Project. As such, no transboundary effects to old growth and mature forests as they relate to fugitive dust or changes in air quality are anticipated to occur.

13.6.6.2 Mitigation Measures

The mitigation measures for old growth and mature forest are based on available BMPs, provincial and federal guidance documents, and professional judgement. The following subsections describe mitigation for the potential Project effects on old growth and mature forest.

13.6.6.2.1 Change in Old Growth and Mature Forest Abundance and Distribution

Clearing of vegetation will remove old growth and mature forest. Key mitigation measures will include the following:

- Minimize Project footprint, to the feasible extent, by clearing only what is required for Operations and
- Delay clearing of areas until required for construction or operation to maintain ecosystem functioning.

13.6.6.2.2 Change in Old Growth and Mature Forest Composition and Vigour

The increase in vehicle traffic through the Landscapes and Ecosystems LSA will contribute to dispersal of invasive plant propagules. Creation of bare ground through various Project activities produces sites for invasive plant propagules to establish. Active monitoring and management will be necessary to prevent the spread of invasive plant species and their impacts. Strategies taken from the Invasive Plant Program Strategic Plan (FLNRORD, 2014b) include:

- Wash all equipment prior to bringing to site;
- Undertake invasive species EDRR for novel invasive plant species incidences;
- Implement the Vegetation and Ecosystems Management and Monitoring Plan to limit the effects that invasive plants may have on natural vegetation;
- Conduct inventories to confirm the current extent of infestations and annual monitoring of infestations to assess effectiveness of treatments;
- Set containment lines (prevention of further spread);
- Avoid seeding of agronomic grasses and legumes for the protection of biodiversity;
- Undertake control activities, including distribution of biocontrol agents, and mechanical and chemical treatments;
- Treat compacted areas and bare soil (e.g., rip haul roads, dump platforms, construction areas) to alleviate compaction and promote establishment of native reclamation species;
- Restore sites with native vegetation species following treatment of invasive infestations;
- Progressive reclamation during Operations to minimize bare soil;
- Implement oil salvage management plan for selective salvage, stockpiling, and prioritization of placement on the site; and
- Apply contouring and erosion control measures within reclaimed site to limit spread of invasive and agronomic species seed and plants.

Invasive species management as specified in the Vegetation and Ecosystems Management and Monitoring Plan pertaining to the management of invasive vegetation will be followed. Effectiveness will be monitored through annual monitoring programs.

Proactive control measures to reduce the generation of dust during activities will be implemented (EMPR and ENV, 2018). Mitigation measures were incorporated from the guidance document Developing a Fugitive Dust Management Plan for Industrial Projects (EMPR and ENV, 2018). The Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1) for the Project will be implemented to reduce the potential impacts of dust on old growth and mature forests. Specific mitigation measures to be implemented to reduce the impacts on old growth and mature forest composition and vigour include:

- Limiting earthmoving activities during windy or unfavorable conditions;
- Completing clearing and grubbing activities in an area-by-area approach, and as efficiently as possible, to avoid drying of exposed materials;
- Locating site infrastructure outside of high wind or wind channelling areas, where feasible;
- Enforcement of low-speed limits for vehicle traffic;
- Decontamination of trucks leaving work areas;
- Covering of truck loads leaving the facility;
- Height limit for debris/waste or gravel stockpiles;
- Revegetation of soil stockpiles with appropriate plant species as soon as possible;
- Wetting active areas including ramps and haul roads within the pit area;
- Utilizing water lubrication of blast hole drilling;
- Timing of blasting, particularly in exposed areas near or above the pit rim, for calm days or calm periods of the day, or use of delay blasting techniques;
- The use of blasting mats to suppress dust emissions;
- Wetting of conveyors and stockpiles using a fog/sprinkler system that releases small droplets of water;
- Minimizing drop heights;
- Minimizing or ceasing dust generating activity during periods of high wind;
- Sweeping paved areas;
- Wetting unpaved areas;
- Designing and constructing roads with the goal of keeping dust levels as low as reasonably achievable, which may include the use of coarser aggregate material on haul roads;
- Application of dust suppressants or crusting agents, if required;
- Covering or enclosing stockpiles and storage areas to shelter them from wind; and
- Establishment of vegetative, other groundcover, or wind breaks.

Metal Concentrations in soil:

- Maintain monitoring program, as per the Baseline Soil and Vegetation Chemistry Report (KES, 2020d), amended to include sampling locations outside of the Project footprint where off-site Project effects may be captured;
- Implement the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4); and
- Implement the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1).

13.6.6.2.3 Summary of Mitigation Measures for Old Growth and Mature Forest

The key mitigation measures proposed to mitigate potential effects on old growth and mature forest are summarized in Table 13.6-13. This table also identifies the anticipated residual effects that will be carried forward in the characterization of residual effects, significance, and likelihood and confidence.

Proposed mitigation measures generally align with standard industry practice, are well understood, and proven to effectively reduce adverse effects on the abundance, distribution, composition, and structure of old growth and mature forest. As it is unlikely that optimization of project design can completely avoid all effects to old growth and mature forest abundance and distribution, confidence with the effectiveness of mitigation measures is considered low. Conversely, confidence in mitigation measures for effects to the structure and composition of old growth and mature forests is high. Where mitigation measures do not or may not mitigate all effects or if there is a low 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.

These proposed mitigation measures are generally accepted, understood, and proven to effectively reduce environmental effects related to fugitive dust and invasive species. The effectiveness of the proposed mitigation measures will be addressed through the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1) and the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

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

Based on the evaluation of potential Project effects on old growth and mature forest, the potential residual effect that may remain after implementation of measures to avoid and minimize adverse effects includes the change in old growth and mature forest abundance and distribution.

13.6.6.3.1 Assessment Methods

The characterization of residual effects follows methods outlined in Chapter 5, Section 5.3.4.5. Ecosystem-specific methods used in the assessment of residual effects are detailed below.

A footprint analysis was used to determine areas of the Project footprint that overlap and interact with old growth and mature forest. The maximum Project footprint extent, including clearing and contingency areas presents the maximum extent of disturbance associated with the Project (as detailed by "Project footprint" line in Figure 13.6-4).

13.6.6.3.2 Potential Residual Effects Assessment

Old growth and mature forest was assessed for potential Project-related changes in abundance and distribution, as well as the potential changes in vigour through introduction and spread of invasive species and dust deposition.

With the successful implementation of mitigation measures, the changes in vegetation vigour associated with the introduction and spread of invasive species and dust deposition were determined to have no residual effects on old growth and mature forest and were not carried forward in the residual effects assessment.

Table 13.6-13: Summary of Proposed Mitigation Measures Related to Old Growth and Mature Forest

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
Change in Old Growth and Mature Forest Abundance and Distribution	• Project design optimization • Implementation of Ecological Restoration Plan • Minimizing disturbance and cleared areas	• Measures contribute to the avoidance, minimization, and restoration of forested ecosystem losses associated with construction, mining, and operational management activities. • Effects of Project development on the abundance and distribution of old growth and mature forest are not expected to be fully mitigated.	• Construction and Pre-Production • Operations • Reclamation and Closure	Low	Yes
Change in Old Growth Forest Composition and Vigour from Spread of Invasive Species and Dust Deposition	<u>Erosion, Deposition of Dust and Airborne Deleterious Substances</u> • Implement the Air Quality and Greenhouse Gas Management Plan, the Soil Management Plan, the Erosion and Sediment Control Plan, the Vegetation and Ecosystems Management and Monitoring Plan, and the Spill Prevention, Control and Countermeasures Plan • Minimize the extent of disturbance within and adjacent to old growth and mature forest • Inspect erosion and sediment control measures • Education and training • Low speed limits • Regular road maintenance	• Recommended measures will contribute to the minimization of Project effects on old growth and mature forest composition and structure. • Effects of erosion, deposition of dust, and airborne deleterious substances in old growth and mature forest are expected to be effectively mitigated such that a residual effect does not occur. • Effects of invasive plants on the composition and structure of old growth and mature forest expected to be effectively mitigated such that a residual effect does not occur.	• Construction and Pre-Production • Operations; • Reclamation and Closure; and • Post Closure	High	No

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases	Effectiveness	Residual Effect
	• Minimize earthworks during windy periods • Progressive reclamation and revegetation • Dust suppression methods • Proper covers/shielding where required • Monitor and inspect dust control measures <u>Invasive Plant Species</u> • Implement the Vegetation and Ecosystems Management and Monitoring Plan • Control, manage, and remove invasive plants on site • Establish buffers and "no-work" zones • Restore with appropriate native vegetation • Education and training • Restrict traffic in known infested areas • Decontaminate vehicles and machinery				

Change in Old Growth and Mature Forest Abundance and Distribution

The residual effect of the Project on the abundance and distribution of old growth and mature forest was characterized according to the change in area of old growth and mature forest relative to baseline conditions in the Landscapes and Ecosystems LSA, as well as established thresholds issued under the KBHLPO.

Clearing of the Project footprint will result in a loss of up to 17% of the old growth and mature forest in the Landscapes and Ecosystems LSA (Table 13.5-17), of which 249 ha has been designated as non-legal Old Growth Management Area.

The KBHLPO includes targets for old growth forest and for old growth forest combined with mature forest[2]. Table 13.6-14 provides a summary of the targets listed in Holmes et al. (2018) for the combinations of Landscape and Biogeoclimatic units that are present in the Landscapes and Ecosystems LSA. Three of the eight landscape/Biogeoclimatic (LU/BGC) units were assessed by Holmes et al. (2018) as being already below the target for old growth forest.

When the loss of old growth forest associated with the Project is included, the following changes occur:

- The 337 ha loss of old growth forest in Alexander-Line/ESSFdk1 will move the LU/BGC unit to slightly below target (-20 ha or -1.7% of the target);
- The 4 ha loss of old growth forest in Alexander-Line/MSdw will result in a further decline below target in this LU/BGC unit, though the change is very small (0.2% incremental decline); and
- The two remaining LU/BGC units with loss of old growth forest due to the Project (221 ha combined) will remain above target.

The Project footprint represents the largest possible extent of clearing and includes a contingency area. Since the decline below target for Alexander-Line/ESSFdk1 and the further incremental decline below target for Alexander-Line/MSdw are both small, it is possible that all LU/BGC units will remain above target for old growth or be unaffected by the Project for those LU/BGC units with no clearing. For the purpose of this assessment, it is conservatively assumed that all areas within the Project footprint will be lost.

Most LU/BGC units in the Landscapes and Ecosystems LSA are medium and high hazard for old growth, meaning the current amount of old growth would be expected less than 13.5% of the time. When mature forest is added to old growth forest, the hazard ratings are lower due to the greater abundance of mature forest. In consideration of the changes in abundance of old growth and mature forest relative to hazard rating:

- The loss of old growth forest due to the Project is in high (4 ha) and medium (550 ha) hazard LU/BGC units; and
- More than half of the loss of old growth and mature forest combined is in medium hazard units.

[2] There are no targets for mature forest on its own.

Table 13.6-14: Change in Old Growth and Mature Forest for Landscape Units and Biogeoclimatic Unit Intersected by the Landscapes and Ecosystems LSA

Landscape Unit	BGC Unit	Old Growth Forest[1]						Old Growth and Mature Forest[1]					
		Target Area in Forested Land Base (FLB; ha)	Actual Area in FLB (ha)	Deviation from Target (ha)	Change due to Project	Net Deviation from Target (ha)	Hazard Rating[2]	Target Area in FLB (ha)	Actual Area in FLB (ha)	Deviation from Target (ha)	Change due to Project	Net Deviation from Target (ha)	Forest Hazard Rating[2]
Corbin Creek (C19)	MSdw	355	202	-153	0	No Change	High	1,058	1,193	337	0	No Change	High
Alexander-Line (C20)	ESSFdk1	1478	1,916	438	-214	224	Med.	2,429	1,269	756	-416	340	Med.
	ESSFdkw	560	741	181	-337	-156	Med.	920	843	664	-375	289	Low
	MSdw	588	220	-368	-4	-372	High	1,091	651	-220	-41	-261	Med.
West Elk (C23; east extent only)	MSdw	1,039	457	-582	0	No Change	High	1,930	1,647	174	-5	169	Med.
East Elk (C38)	ESSFdk1	218	951	733	0	No Change	Med.	651	1,142	1,442	0	No Change	Low
	ESSFdkw	24	0	-24	0	No Change	V. High	72	255	183	0	No Change	V. Low
	MSdw	N/A	NA	N/A	-7	N/A	N/A	N/A	N/A	N/A	-74	N/A	N/A

[1] All data, except amounts removed by the Project, are from the EV-CEMF (Holmes et al., 2018). Only those BGC units present in the Landscapes and Ecosystems LSA are shown.
[2] Hazard is the deviation of the current amount from the range of expected amounts that would have occurred historically through natural variation. The categories are as follow:

- Very Low = Existing amount of forest is expected to occur 50% of the time historically;
- Low = Existing amount of forest is expected to occur 34% of the time historically;
- Medium = Existing amount of forest is expected to occur 13.5% of the time historically;
- High = Existing amount of forest is expected to occur 2% of the time historically;
- Very high = Existing amount of forest is expected to occur 0.5% of the time historically.

[3] Targets not reported (N/A) for units with <10 ha.

13.6.6.3.3 Characterization of Residual Effects

The assessment of residual effects on old growth and mature forest 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.

Change in Old Growth and Mature Forest Abundance and Distribution

The residual effect to old growth and mature forest from change in abundance and distribution from vegetation removal is characterized as follows:

- Duration: Permanent, as lost old growth and mature forest will take longer than 34 years to recover.
- Magnitude: High, as there will be a 17% loss of old growth and mature forest in the Landscapes and Ecosystems LSA, of which some losses will result in or further sustain declines of old growth and mature forest below minimum target thresholds.
- Geographic Extent: Discrete, as the effect of habitat loss will be within the Project footprint only.
- Frequency: Continuous, the loss of old growth and mature forest is continuous until lost habitat is reclaimed.
- Reversibility: Irreversible, as reclaimed areas will not support mature forest for at least 100 years and old growth for at least 140 years.
- Context: Low, as old growth forest has very low resilience and the amount of old growth is much less than the historical mean.

Determination of Significance

Given that the Project is predicted to result in a loss of old growth, as well as old growth and mature forest to below threshold levels for several Landscape and BGC Units, the residual effect of change in abundance on old growth and mature forest is considered to be significant. The Project footprint contains a relatively large amount of old growth and mature forest and is proportionally higher than found in the larger Landscapes and Ecosystems LSA (66% versus 39%). Approximately 17% of the old growth and mature forest in the Landscapes and Ecosystems LSA will be lost to clearing of the Project footprint. Although implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) includes the restoration of 484 ha of forest, a total of 851 ha of old growth and mature forest will be removed. Consequently, there will be a net reduction in forested lands with potential to become mature and old growth forest. In the absence of other disturbances (e.g., fire, insect damage, or forest harvesting), these restored areas will become mature and eventually old growth forest, though not for at least 100 to 120 years (depending on the BGC unit) for mature forest and 140 years for old growth forest.

Likelihood and Confidence

The loss of old growth and mature forest will occur with certainty and likelihood is therefore high. The extent of old growth and mature forest is well understood, though the precise amount lost will depend on detailed design and how much of the contingency areas will be used. For example, not all of the Project footprint along the access road and utility corridor will require clearing. The loss of old growth and mature forest may be less than assumed here; conservatism has been applied to counter this uncertainty. The EV-CEMF indicators used to support the determination of significance are based on models and assumptions, which have their own uncertainly and limitations (Holmes et al., 2018). Confidence in the prediction of the residual effect is moderate.

13.6.6.3.4 Summary of Residual Effects Assessment

Residual effects and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 13.6-15.

13.6.7 Project Effects on Wetland Ecosystems

13.6.7.1 Discussion of Potential Effects

In general, the Project has the potential to affect wetland ecosystems through:

- Direct (physical) loss of wetland area or function due to site clearing and grubbing, logging of timber, and soil movement/salvage;
- Indirect loss or change in function due to dust deposition associated with construction, transportation, mining, and coal processing activities;
- Loss or change in function due to invasive plant species introduction and/or encroachment along transportation/utility corridors, construction/dismantling areas, and during soil salvaging and stockpiling activities; and
- Loss or change in function due to erosion and the addition of sediment, nutrients, and contaminants.

Potential effects on wetland ecosystems as a result of the Project that are carried forward in the discussion of potential effects are summarized in Table 13.6-16.

The potential effects identified in Table 13.6-16 are discussed in the context of each Project phase (Construction and Pre-Production, Operations, Reclamation and Closure, and Post-Closure) in the following subsections.

13.6.7.1.1 Change in Wetland Ecosystem Extent from Clearing, Grubbing, Logging, and Soil Salvaging

The Project is expected to result in the direct loss of less than 1 ha of wetland ecosystems (Table 13.6-17; Figure 13.6-5Figure 13.6-5). Wetlands within the Project footprint are anticipated to be directly lost as a result of site preparation and construction activities resulting in a permanent loss of wetland ecosystems. Reclamation of the Project footprint will offset impacts to wetlands as new wetland habitat is constructed within disturbance footprint through on-site compensation in the Reclamation and Closure phase.

Table 13.6-15: Summary of Residual Effects on Old Growth and Mature Forest

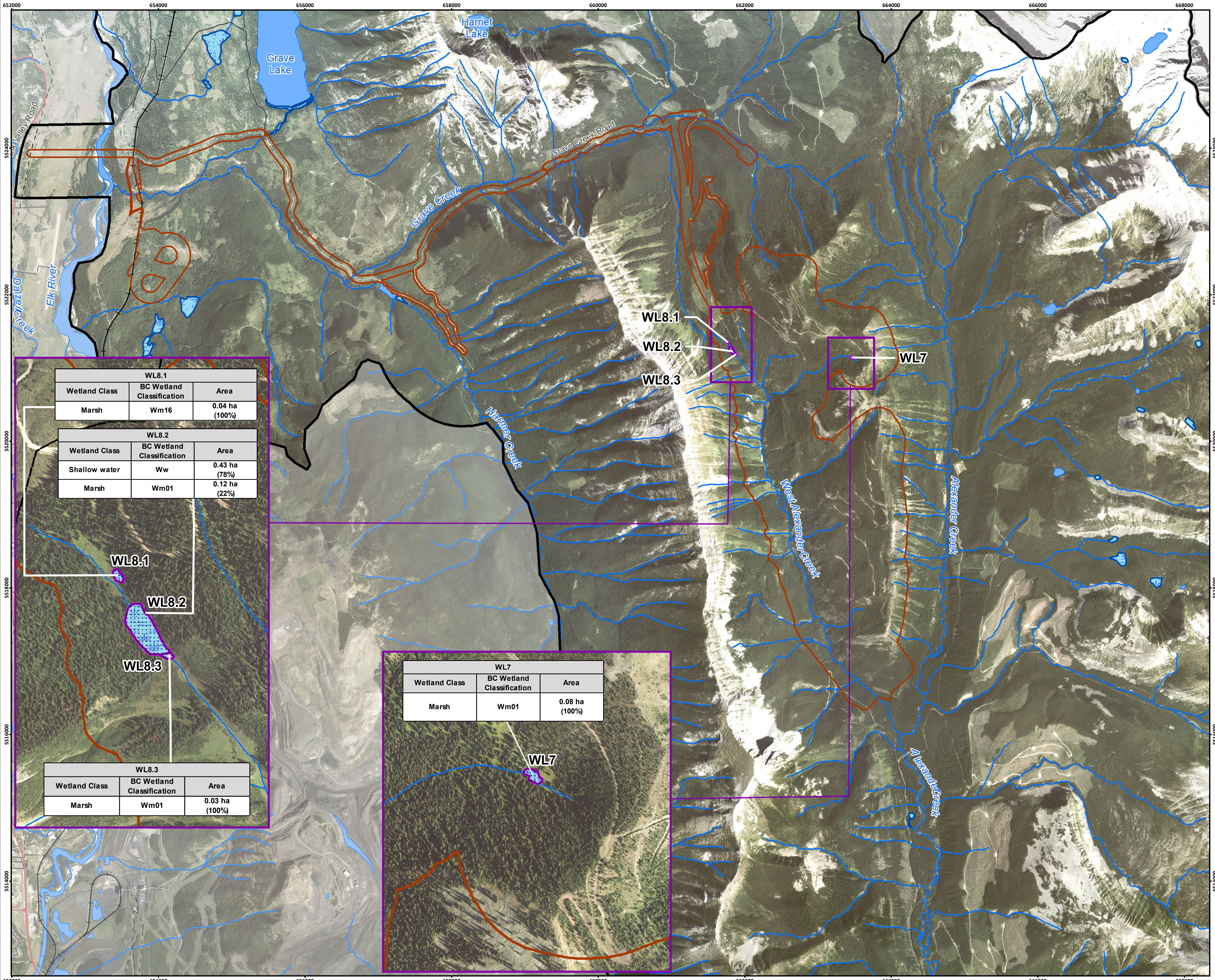
Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Likelihood (High, Moderate, Low)	Confidence (High, Moderate, Low)
Change in Old Growth and Mature Forest Abundance and Distribution	• Construction and Pre-Production • Operations	• Project design optimization - limit Project footprint and clearing near old growth and mature forest areas to the extent feasible • Implementation of Ecological Restoration Plan • Minimizing disturbance and cleared areas Delay construction areas of mine components until ready to mine	Duration: Permanent Magnitude: High Geographic Extent: Discrete Frequency: Once Reversibility: Irreversible Context: Low	Significant	High	Moderate

Table 13.6-16: Potential Effects on Wetland Ecosystems

Potential Effect	Rationale for Selection of Environmental Effect
Change in Wetland Ecosystem Extent from Clearing, Grubbing, Logging, and Soil Salvaging	Direct loss of wetlands to make way for Project components will result in a loss of wetland functions provided by wetlands within the Project footprint. Land clearing and grubbing, logging of timber in the development footprint, and salvaging of wetland soils will result in the physical loss of wetlands within the Project footprint and an associated loss of the wetland functions provided by affected wetlands.
Change in Wetland Ecosystem Functions from Other Project Activities	The use of Project transportation corridors, such as access and haul roads for on-site transportation of personnel and construction materials, the blasting of bedrock, and coal processing may generate dust and result in indirect changes to wetland habitat and biochemical functions through the alteration of wetland surface water (i.e., pH) and nutrient concentrations and changes in wetland plant growth and vigour.
	Invasive plant species may be introduced to wetland ecosystems through the use of the transportation/utility corridor (e.g., access and haul roads) and increased vehicle traffic, soil salvaging and stockpiling, and the increase of exposed/bare soils over the progressive reclamation of the site, potentially indirectly altering wetland habitat and hydrological function.
	Erosion of upland habitat or areas adjacent to wetland ecosystems can result in sedimentation, the addition of nutrients, and the contamination of wetland surface water quality. Erosion and sedimentation during site clearing, construction, and reclamation activities could result in elevated levels of total suspended solids and turbidity in nearby watercourses and wetlands. Impacts to surface water quality may alter wetland hydrological, biochemical, and habitat functions.
	Removal of vegetation through clearing and grubbing in areas adjacent to wetland ecosystems may alter wetland habitat functions as a result of decreasing riparian habitat and habitat availability.

Table 13.6-17: Loss of Wetland Ecosystem Extent

Project Component or Activity	Wetland Survey ID	BEC Zone	Wetland Class	Ecosystem Name	Structural Stage	Estimated Loss (ha)
Mining of East Pit	WL7	ESSFdkw	Wm01	Beaked sedge - Water sedge	2b (graminoid-dominated)	0.08
Office/Shop Construction; Mine Rock Storage	WL8.1	ESSFdk1	Wm16	Bluejoint - Arrow-leaved groundsel	2b (graminoid-dominated) / 2a (forb-dominated)	0.04
	WL8.2	ESSFdk1	Ww (78%)	Shallow water	2c (aquatic)	0.42
			Wm01 (22%)	Beaked sedge - Water sedge	2b (graminoid-dominated)	0.12
	WL8.3	ESSFdk1	Wm01	Beaked sedge - Water sedge	2b (graminoid-dominated)	0.03
					Total	0.69



WL8.1		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm16	0.04 ha (100%)

WL8.2		
Wetland Class	BC Wetland Classification	Area
Shallow water	Ww	0.43 ha (78%)
Marsh	Wm01	0.12 ha (22%)

WL8.3		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.03 ha (100%)

WL7		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.08 ha (100%)

Crown Mountain Coking Coal Project

Figure 13.6-5
Wetland Ecosystem Loss

- Wetland Ecosystem Loss
- Surveyed Wetland Ecosystem
- Landscapes and Ecosystems Local Study Area
- Project Footprint
- Highway
- Arterial/Collector Road
- Local/Resource Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- British Columbia/Alberta Border

0 1 2
Kilometres

Scale 1:50,000

Map Drawing Information:
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Construction and Pre-Production

Construction and Pre-Production activities are anticipated to directly affect four wetlands within the Project footprint (i.e., wetlands WL7, WL8.1, WL8.2, and WL8.3). Wetlands will be directly affected by site clearing and grubbing, logging of timber in preparation for site development, and salvaging of wetland soils (Table 13.6-17; Figure 13.6-5), resulting in a permanent loss of those four wetlands. A total of 0.69 ha of wetlands will be removed, consisting of 0.41 ha of marsh wetland (Wm01 and Wm16 site associations) and 0.52 ha of shallow water wetland (Ww and Ww Yellow pond-lily Type; Table 13.6-17). Structural stages of impacted wetlands include graminoid-dominated and aquatic stages. No listed (Red or Blue-listed) plants or plant communities occur within wetlands that will be directly lost as a result of Project activities.

Wetlands within the mine footprint, marsh and shallow open water wetlands, provide several hydrologic, biochemical and habitat functions (Table 13.5-28). Loss of these wetlands has the potential to reduce habitat availability for a variety of terrestrial species, including birds (e.g., migratory birds), amphibians, and fish, reduce sediment and particulate retention in the headwaters of West Alexander Creek, reduce wetland carbon sequestration and storage, and reduce the diversity of uncommon native plant communities.

Excavations associated with open pit mining can result in the loss or change of wetland function due to hydrological changes arising from the presence of excavations near wetlands, resulting in wetland dewatering. Wetland dewatering is not anticipated to occur as a result of Project activities as wetlands within the Project footprint will be removed during the Construction and Pre-Production phase and site clearing activities.

Operations

No potential adverse effects to wetland extent are anticipated to occur during Operations that did not occur during the Construction and Pre-Production phase. Wetland loss will be experienced in the initial site clearing and grubbing activities and no additional loss to wetland ecosystems are anticipated during Operations; however, indirect changes or loss of wetland area or function could occur due to Operations activities that result in adverse effects in wetlands near the Project footprint. Examples of such changes include dust deposition onto wetlands and their vegetation, or the introduction of invasive plant species into wetlands arising from Project activities. The extent of these changes (if any) would be identified through follow-up, monitoring, and adaptive management as required.

Reclamation and Closure

The planned reclamation of ecosystems and landscapes in the Reclamation and Closure phase is anticipated to result in a net positive contribution to wetland ecosystem extent in the Project footprint, as detailed in the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3). Up to 10 ha will be reclaimed as newly constructed wetland ecosystems created within the disturbance footprint and are anticipated to achieve a state as a functional wetland ecosystem by the end of the Post-Closure Phase.

Post-Closure

No potential adverse effects to wetland extent are anticipated to occur during Post-Closure. Wetland areas reclaimed during the Reclamation and Closure phase are assumed to be functioning as normally by the time the Post-Closure phase begins (see Section 13.8 for more information).

13.6.7.1.2 Change in Wetland Ecosystem Functions from Other Project Activities

Wetlands in close proximity or adjacent to the Project footprint, including WL9, WL10, and WL11.1, have the potential to experience alteration in wetland function as a result of:

- Dust deposition;
- Invasive plant species introduction or encroachment;
- Removal of riparian vegetation and soil compaction; and
- Erosion and sedimentation, and the introduction of nutrients and contaminants.

Changes to wetland functions may result in indirect adverse effects to wetland and wetland complex composition and structure, such as changes in wetland species richness, composition, vegetation density, presence of invasive species, and changes in wetland spatial extent.

Construction and Pre-Production

The Construction and Pre-Production phase has the potential to adversely affect the function of several wetlands in proximity to the Project footprint due to the generation of dust, the introduction and encroachment of invasive plants, and changes in West Alexander Creek streamflow. Dust generation associated with construction of the haul road along Grave Creek, the use of the haul road to transport materials to site, the rail loadout and associated infrastructure, and mining have the potential to affect wetland function and result in decreased plant vigour and decreased palatability of the dust-covered vegetation to herbivores and pollinators. Increased airborne particulate matter from dust can impact water and soil chemistry, which can have adverse effects on vegetation in wetlands that may be inhabited by Red- and Blue-listed plant communities.

In Construction and Pre-Production, the removal of vegetation within the riparian area of wetlands along the Grave Creek Road may alter wetland function through a reduction in habitat availability and suitability, increase the potential for erosion, and encourage invasive species establishment (Hanson et al., 2008). Vegetation removal adjacent to wetlands can also increase wetland water temperatures and cause fragmentation of a wetland ecosystem, resulting in a reduction of biodiversity (Hanson et al., 2008). The Project has been designed to avoid wetland areas adjacent to transportation/utility corridor, such as those wetlands along Grave Creek Road (i.e., WL11.1, WL9, and WL10), and as such, alteration of riparian habitat associated with wetlands is anticipated to be minimal. The existing road shoulder adjacent to wetland areas will be maintained and no direct encroachment into wetland areas is anticipated to occur.

As a result of Construction and Pre-Production activities, erosion and sedimentation may occur in watercourses adjacent to the Project footprint as a result of land clearing, grubbing, and mine site development preparation. In some areas adjacent to the Project footprint and wetland ecosystems, little to no riparian areas around wetland occurs (i.e., WL9, WL10, and WL11.1), and wetlands occur along the base of the road or toe of slope of Grave Creek Road. Road upgrading and installation of the utility corridor along Grave Creek Road will require clearing and grubbing of vegetation to allow for road widening, culvert installation, and bridge upgrades. These activities could result in erosion of exposed soils and sedimentation in watercourses adjacent to the road. Increased sedimentation in wetlands can adversely affect wetland function through decreased surface water storage, increased surface runoff, reduced water quality, and a reduction in habitat productivity, species richness, and decreased shallow water habitat (Hanson et al., 2008).

Contributions of nutrients (i.e., phosphorus and nitrogen) and contaminants can occur concurrently with sedimentation from runoff and erosion. Sedimentation can facilitate phosphorous and contaminant dropout or filtering, which is also be influenced by underlying soils, plant density, and plant uptake. The introduction of nutrients can affect plant growth and plant species composition in wetlands. Nutrients can affect wetlands that receive no or little nutrient-rich groundwater, such as bogs and poor fens. The deposition of windborne nutrients may have similar effects on wetlands, especially those hydrologically isolated from groundwater.

The opportunity for invasive plant species to establish or expand at wetlands in proximity to the Project footprint increases during Construction and Pre-Production. Use of the transportation/utility corridor, such as the Grave Creek Road, by off-site and unwashed vehicles and machinery can increase the potential for the introduction of invasive plants to wetland ecosystems along the haul road. The disturbance and movement of soils adjacent to wetland areas during site preparation and widening of the Grave Creek Road right-of-way also has the potential to create an opportunity for invasive establishment, as exposed soils create an opportunity for invasive plants to spread rapidly. As noted in Table 13.5-27, several invasive plants were documented at WL9 and WL10 during baseline surveys, including oxeye daisy and Canada thistle. Establishment or the increase of invasive plants at wetlands can impact both wetland habitat and hydrological functions through a reduction in native plant diversity, changes in plant densities and stem density of emergent species, and reduced or increased water availability through changes in uptake and increased or reduced obstruction and flows.

Operations

The generation of dust during Operations is anticipated as a result of mining activities and the use of the transportation/utility corridor to move materials to/from the site and hauling of coal to the rail load-out and during loading of rail cars. As noted for Construction and Pre-Production, dust deposition and accumulation on vegetation can affect wetland function through reduced plant vigour, decreased palpability to terrestrial species, and alteration of surface water and soil chemistry.

Over the course of the Operations phase, Project activities have the potential to spread and introduce invasive plant species through the use of the transportation/utility corridor and the traffic of off-site and unwashed vehicles and machinery. Invasive plants are commonly found along roads in B.C., and with the proximity of wetland ecosystems to Project transportation/utility corridor (e.g., Grave Creek Road), there is a potential for increased spread of invasive plants to wetland ecosystems. Invasive plants can impact both wetland habitat and hydrological functions through a reduction in native plant diversity, changes in plant densities and stem density of emergent species, and reduced or increased water availability through changes in uptake and increased or reduced obstruction and flows.

Reclamation and Closure

Over the course of site reclamation and closure, limited amounts of dust may be generated through the decommissioning of site infrastructure (e.g., rail loadout and access roads), reclamation of disturbed areas, and use of transportation corridors (i.e., Grave Creek Road) as materials are moved from the site. Dust suppression will be on-going through reclamation activities, specifically the transportation of materials offsite, to reduce adverse effects on wetlands adjacent to the transportation/utility corridor.

As with the Construction and Pre-Production and Operations phases, invasive species introduction and spread can occur during Reclamation and Closure and materials are brought to and from the site for the decommissioning of mine infrastructure. Site re-grading during decommissioning may increase the potential for erosion of exposed surfaces, resulting in the potential for sedimentation in wetlands and reduced species richness through infilling of wetland areas.

Post-Closure

No potential adverse effects to wetland function are anticipated to occur during Post-Closure. The wetland functions created as part of the Reclamation and Closure phase are assumed to be functioning as intended as by the time Post-Closure begins and will be monitored as per the follow-up strategy outlined in Section 13.8.

13.6.7.1.3 Transboundary Effects

As described in Section 13.6.3.1.3, the Project is located approximately 5 km west of the Alberta border, approximately 85 km north of the Montana border, and does not overlap with federal lands. The most frequent wind direction recorded at the Project baseline climate station was from the southeast while the wind data recorded at the Sparwood CS station is predominant northerly and southerly. The atmospheric environment assessment (Chapter 6, Section 6.5.4.2.1) concluded that no measurable transboundary effects on air quality in Alberta, the United States, or on federal lands are anticipated to occur as a result of the Project. As such, no transboundary effects to wetland ecosystems as they relate to fugitive dust or changes in air quality are anticipated to occur.

13.6.7.2 Mitigation Measures

The mitigation measures proposed for wetland ecosystems are based on available BMPs, provincial and federal guidance documents, mitigation measures conducted and accepted for similar projects, and professional judgment. 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 (B.C. MOE, 2014a and B.C. MOE, 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 wetland ecosystems. 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 wetland ecosystems. Potential Project-related changes to wetland ecosystems will be reduced through design mitigation, regulatory requirements, site reclamation, and BMPs, including management plans, monitoring, and adaptive management. Where mitigation measures are considered to be completely effective, potential Project effects to wetland ecosystems are not identified as residual effects.

The following subsections describe mitigation for the following potential Project effects on wetland ecosystems from changes in wetland extent and changes in wetland function.

13.6.7.2.1 Mitigation Measures for Change in Wetland Ecosystem Extent from Clearing, Grubbing, Logging, and Soil Salvaging

Although much of the Project development focuses on upland areas, wetland ecosystems have the potential to be affected through site clearing and grubbing activities, and the removal of vegetation and soil. The primary measure to mitigate changes in wetland extent is to avoid wetland ecosystems. Where avoidance within the Project footprint is not possible, the direct loss of wetland ecosystems will be addressed through a series of mitigation measures, including on-site compensation. While the wetland function lost cannot be completely recreated, some wetland values and function can be restored within the Project footprint to offset losses to wetland functions experienced in Project construction. As part of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3), new wetland ecosystems within the Project footprint will be created through on-site wetland habitat compensation to restore wetland ecosystem spatial extent and wetland function lost through site development.

To mitigate the change in wetland extent within the Project footprint and to reduce further loss of wetland extent over the course of the Project, the following mitigation measures will be implemented:

- Implementation of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) to compensate for direct losses of wetland ecosystems and associated wetland function;
- Minimize disturbance and encroachment into existing wetlands and related riparian areas, to the extent feasible, by clearing and grubbing only what is required for Construction and Pre-Production activities and development of the Project;
- Survey and record additional wetland areas observed during pre-clearing surveys (anticipated to be small) and collect information on the wetland delineation, classification, and functions;
- Implement the Soil Management Plan (Chapter 33, Section 33.4.1.9) to salvage and stockpile soils from wetland areas removed during the Construction phase for future reclamation activities;
- Use the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4) to reduce indirect impacts to adjacent wetland habitat where partial losses of wetlands are anticipated;
- Create wetlands during progressive reclamation activities; and
- Monitor reclaimed areas to evaluate effectiveness of the Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) in meeting compensation goals and objectives.

Information collected as part of follow-up programs (Section 13.8) will be used to inform success of reclamation and compensations strategies and determine, if necessary, the implementation of appropriate adaptive management strategies to achieve replacement of wetland extent and functions.

13.6.7.2.2 Mitigation Measures for Change in Wetland Ecosystem Functions from Other Project Activities

Wetland biochemical, habitat, and hydrological functions have the potential to be indirectly affected as a result of Project activities, including site clearing and grubbing, the removal of vegetation and soil, and the widening of existing access roads to allow for the haul road and utility corridor. Project activities can indirectly alter wetland function through the deposition of dust on wetland vegetation, soils, and surface water, invasive species introduction, sedimentation and infilling of wetlands, and the removal of wetland vegetation and riparian areas leading to wildlife habitat disturbance and decreased wetland function. Changes in wetland functions may result in indirect adverse effects to wetland composition and structure.

Potential effects on wetland functions will be minimized through avoidance, minimization, and restoration strategies. Avoidance of wetland areas is the best way to reduce the potential for alternation of wetland functions. In conjunction with avoidance, specific strategies to control impacts from Project activities will be implemented to reduce dust and invasive species introduction, control erosion and sedimentation, and reduce the potential for edge effects on wetland functions.

Dust Deposition

Over the course of Construction and Pre-Production, Operations, and Reclamation and Closure, dust has the potential to be generated through construction activities and the use of the transportation/utility corridor and the rail loadout, which may result in dust accumulation on wetland vegetation. The primary measure to mitigate changes in wetland function as a result of dust is to reduce dust generation and deposition within the Project footprint and implementation of the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1).

Specific mitigation measures to be used to control the generation and deposition of dust and reduce the potential for adverse effects on wetland ecosystem function include but are not limited to:

- Enforcement of low speed limits for vehicular traffic throughout the site, such as along Grave Creek Road;
- Maintain unpaved roads and keep in good repair, including regular road compaction and use of coarse aggregate with low silt content, where possible;
- Create exclusion zones around wetland ecosystems through implementation of the Air Quality and Greenhouse Gas Management Plan (Chapter 33, Section 33.4.1.1);
- Conduct earthmoving activities in a manner that reduces exposed soils and avoids dust-generating activities during windy periods, where possible;
- Implement water or dust suppression methods during dry periods from May to November to mitigate dust generation in areas including unpaved roads and work areas, where required. 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;
- Apply and use dust suppression measures such as wetting work areas and stockpiles, installing equipment covers, and using dust hoods and shields at the rail loadout;
- Implement the Soil Management Plan (Chapter 33, Section 33.4.1.9);
- Locate soil stockpiles at appropriate locations far from wetland ecosystems, and store and shape in ways to allow for slope stability and reduce moisture content loss, including establishment of vegetation to reduce exposure to wind and water erosion;
- Use progressive reclamation and revegetation throughout the mine life to minimize wind erosion potential and reduce the Project footprint, minimizing the potential for dust deposition to nearby watercourses;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to wetland ecosystems; and

- Monitor and inspect air dust control measures are effective and functioning properly, which will allow for timely maintenance and adjustments as required.

Invasive Plants

Invasive plant species can establish quickly and easily on both disturbed and undisturbed sites and cause wide-spread negative economic, social, and environmental impacts (ISCBC, 2019). Project construction and operation activities, from site preparation to reclamation, can encourage invasive plant establishment and spread through machinery and vehicle use and movement, ground disturbance activities, and use potentially infested soils or materials within the Project footprint. Implementation of the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11) and specific measures to control and eradicate invasive plants is integral to protecting wetland functions.

Prior to construction, it is anticipated that a Project-specific management plan for invasive plants will be developed as an operational guide to manage invasive plants within the Project footprint and be implemented across the footprint over the course of the Project to control existing and future invasive plant populations.

Measures to control existing invasive plant populations and reduce the potential for the introduction of additional invasive plants in Construction and Pre-Production, Operations, and Reclamation and Closure include:

- Identify and demarcate invasive plant populations around wetland areas prior to construction;
- Establish setback areas and "no-work" areas if invasive plant populations are located near wetlands to reduce the spread of invasive plants by machinery and vehicles;
- Remove existing plant populations near wetlands to prevent the spread to adjacent areas;
- Undertake invasive control activities, including distribution of biocontrol agents, and mechanical and chemical treatments;
- Reduce exposure of bare ground near wetlands;
- Restore sites with native vegetation species following treatment of invasive infestations and ground disturbance to establish vegetative cover;
- Establish an EDRR plan in accordance with the Government of B.C. guidance and monitor for new invasive plants of concern near wetland areas through the follow-up and monitoring programs (Section 13.8);
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to wetland ecosystems;
- Restrict vehicle and machinery traffic to designated access roads; and
- Apply contouring and erosion control measures to limit spread of invasive and agronomic species seed and plants.

Additional mitigation measures related to invasive species management are provided in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

Vegetation Removal and Soil Compaction

The Project design optimizes the use of the Grave Creek Road and road shoulder adjacent to wetland ecosystems to avoid direct impacts to existing wetland ecosystems. Indirect effects of the Project, particularly in the Construction and Pre-Production phase, could include removal of vegetation, such as riparian areas around wetlands, and soil compaction. The following mitigation will be implemented to reduce the potential for indirect adverse effects to wetland ecosystems adjacent to the Project footprint:

- Avoid the removal of wetland vegetation and riparian areas over the course of Project activities;
- Conduct pre-construction surveys to delineate "no-work" zones and establish buffers and setbacks to maintain wetland shape, structure, and function;
- Establish buffers and setbacks where riparian areas are located adjacent to wetlands along Grave Creek Road as per the Forest Practices Code Riparian Management Area Guidebook (Province of British Columbia, 2021);
- Establish buffers around sensitive areas, such as wetlands and riparian areas, prior to construction, as outlined in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11) to protect wetland ecosystems, riparian habitat, and watercourses adjacent to roadways;
- Minimize disturbance to wetland riparian areas, to the extent feasible, by clearing and grubbing only what is required for Construction and Pre-Production activities and development of the Project;
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to wetland ecosystems;
- Complete construction activities around wetlands during periods of least risk windows to minimize impacts to sensitive periods for terrestrial and aquatic species as per provincial and federal legislation and the strategies outlined in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11); and
- Minimize compaction of soils near wetlands as per the Soil Management Plan (Chapter 33, Section 33.4.1.9).

Erosion, Sedimentation, and Water Quality

Project construction activities occurring near wetland ecosystems adjacent to the Project footprint have the potential to remove vegetation near wetlands, expose soils, and increase sediment-laden surface water runoff to wetlands. These activities can result in changes in wetland biochemical, hydrological, and habitat functions. Over the course of Construction and Pre-Production, the potential for erosion and sedimentation near wetlands will be controlled through implementation of the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4). Specific mitigation measures to reduce the potential for adverse effects to wetland ecosystem function as a result of erosion and sedimentation include:

- Implement standard erosion and sediment control practices as outlined in the Erosion and Sediment Control Plan to reduce the potential sedimentation and infilling of wetlands (Chapter 33, Section 33.4.1.4);
- Retain vegetated areas around wetlands, including riparian areas;
- Limit exposed soils near wetlands to reduce the potential for erosion and sedimentation;
- Avoid altering the hydrological connectivity of watercourses connected to wetlands and wetland drainage areas;
- Monitor water quality in wetlands adjacent to the Project footprint to evaluate changes in water quality as per the Erosion and Sediment Control Plan (Chapter 33, Section 33.4.1.4);
- Provide appropriate training and education for employees and contractors on management plans and how to minimize effects to wetland ecosystems;

- Conduct regular inspections of control measures established to address erosion and sedimentation and complete necessary repairs in a timely manner to protect wetland ecosystems;
- Direct drainage ditches of transportation/utility corridor to vegetated areas or existing drainage pathways instead of to wetland areas as per the Site Water Management Plan (Chapter 33, Section 33.4.1.8); and
- Reduce the potential for accidental spills and contamination of wetland ecosystems, including soils, surface water, and groundwater, through implementation of the Spill Prevention, Control and Countermeasures Plan (Chapter 33, Section 33.4.1.10).

13.6.7.2.3 Summary of Mitigation Measures for Wetland Ecosystems

The key mitigation measures proposed to mitigate potential effects to wetland ecosystems are summarized in Table 13.6-18. Anticipated residual effects that will be carried forward in the characterization of residual effects, significance, and likelihood and confidence are outlined in Table 13.6-18.

Mitigation measures proposed to reduce adverse effects to wetland ecosystems are generally accepted, understood, and proven to effectively reduce adverse effects on wetlands and wetland functions. Although the Project layout and design optimization cannot avoid all effects to wetland ecosystems, the effectiveness of proposed mitigation measures is rated as moderate as reclamation of impacted wetlands will result in a moderate improvement of the VC. Where mitigation measures do not or may not mitigate all effects or if there is a low 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.

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 Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11).

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

Based on the evaluation of potential Project effects on wetland ecosystems, the potential residual effect that may remain after implementation of measures to avoid and minimize adverse effects includes the change in wetland ecosystem extent due to clearing, grubbing, logging, and soil salvaging.

13.6.7.3.1 Assessment Methods

The characterization of residual effects follows methods outlined in Chapter 5, Section 5.3.4.5. Ecosystem-specific methods used in the assessment of residual effects are detailed below, if applicable. A footprint analysis was used to determine areas of the Project footprint that overlap and interact with wetland ecosystems. The maximum Project footprint extent, including clearing and contingency areas, presents the maximum extent of disturbance associated with the Project (as detailed by "Project footprint" line in Figure 13.6-5). Interaction of surveyed wetland spatial extent and the Project footprint is considered a direct loss of wetland ecosystem abundance in the Terrestrial LSA. To determine wetland functions lost associated with direct losses of wetlands within the Project footprint, the Project-specific wetland function assessment (Appendix 13-D) was used.

Table 13.6-18: Summary of Proposed Mitigation Measures Related to Wetland Ecosystems

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases)	Effectiveness	Residual Effect?
Change in Wetland Ecosystem Extent due to Clearing, Grubbing, Logging, and Soil Salvaging	• Project design optimization • Implementation of Ecological Restoration Plan • Reclamation of wetland ecosystems • Minimizing disturbance and cleared areas • Document new wetland areas observed in Project footprint • Monitor reclaimed wetlands and wetland function	• Measures contribute to the avoidance, minimization, and restoration of wetland ecosystems and wetland functions losses associated with Project activities. • Effects of Project development on wetland ecosystem extent are not expected to be fully mitigated.	• Construction and Pre-Production • Reclamation and Closure	Moderate	Yes
Change in Wetland Ecosystem Function due to Other Project Activities	<u>Dust Deposition:</u> • Project design optimization. • Implementation of Air Quality and Greenhouse Gas Management Plan, Soil Management Plan, and the Vegetation and Ecosystems Management and Monitoring Plan • Progressive reclamation and revegetation • Dust suppression methods • Exclusion zones • Manage machinery and vehicle speed limits • Road maintenance • Vehicle covers and decontamination • Manage timing of construction and earthmoving activities • Education and training • Monitor and inspect dust control measures	• Dust reduction strategies will reduce dust deposition on wetland vegetation, surface water, and related wetland functions. • Effects of dust on wetland function are expected to be effectively mitigated such that a residual effect does not occur.	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases)	Effectiveness	Residual Effect?
	<u>Invasive Plants:</u> • Implement an EDPR system • Implement the Vegetation and Ecosystems Management and Monitoring Plan • Control, manage, and remove invasive plants on site • Establish buffers and "no-work" zones where current infestations • Restore with appropriate native vegetation • Education and training • Restrict traffic in known infested areas • Decontaminate vehicles and machinery	• Prevention of the introduction and movement of invasive plants on site is important to controlling invasive plant impacts on wetlands. Management strategies proposed contribute to the avoidance and minimization of effects of invasive plants on wetland function. EDRR systems can be effective in limiting and preventing the spread of invasive plants. • Effects of invasive plants on wetland function are expected to be effectively mitigated such that a residual effect does not occur.	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No
	<u>Vegetation Removal and Soil Compaction</u>: • Implement the Vegetation and Ecosystems Management and Monitoring Plan, Soil Management Plan, and Fish and Fish Habitat Management Plan • Avoid removal of riparian vegetation • Establish buffers and "no-work" zones around wetland ecosystems • Adhere to least risk windows • Education and training • Minimize soil compaction near wetlands	• Buffers and timing windows will reduce the potential adverse effects to vegetation around wetlands and the opportunity for soil compaction. The measures outlined contribute to the avoidance and minimization of impacts to wetland function as a result of vegetation removal and soil compaction.	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No

Potential Effect	Mitigation Measures	Rationale	Applicable Project Phases)	Effectiveness	Residual Effect?
	Erosion, Sedimentation, and Water Quality: • Implement Erosion and Sediment Control Plan, Spill Control Prevention Plan, and the Site Water Management Plan • Retain vegetated areas near wetlands • Limit exposed soils near wetlands • Avoid altering wetland drainage areas • Monitor water quality • Inspect erosion and sediment control measures • Education and training • Avoid draining water to wetlands	• Erosion and sediment control measures will contribute to the avoidance and minimization of impacts to wetland water quality and function. • Effects of erosion and sedimentation on wetland function are expected to be effectively mitigated such that a residual effect does not occur.	• Construction and Pre-Production • Operations • Reclamation and Closure	High	No

13.6.7.3.2 Potential Residual Effects Assessment

Change in Wetland Ecosystem Extent Due to Clearing, Grubbing, Logging, and Soil Salvaging

The effect on wetland ecosystem spatial extent represents a residual effect due to the physical loss of wetland area due to the development of Project infrastructure and the time required to restore wetland ecosystem function and extent to that of baseline conditions. A total of 0.69 ha of wetland area will be permanently lost from four wetlands within the Project footprint (WL7, WL8.1, WL8.2, and WL8.3) as a result of activities carried out in the Construction and Pre-Production phase (Table 13.6-17). The direct effect to wetlands includes the loss of wetland vegetation and vegetation complexes (i.e., WL8.2), loss of wetland soils, and loss of wetland catchment/drainage areas connected to the Alexander Creek watershed. Wetlands directly affected by the Construction and Pre-Production phase include 0.27 ha of marsh and 0.42 ha of shallow open water. No sensitive or listed plant species or plant communities were documented in the wetlands anticipated to be lost as a result of the Project.

Direct losses of wetland ecosystems include the loss of wetland functional capacity associated with impacted wetlands. An overview of the functional capacity of each affected wetland is summarized below:

- WL7 (0.08 ha) – Provides low hydrologic, moderate biochemical, and low to moderate habitat functional capacity;
- WL8.1 (0.04 ha) – Provides low to moderate hydrologic, low to moderate biochemical, and moderate habitat functional capacity;
- WL8.2 (0.54 ha) – Provides moderate hydrologic, moderate biochemical, and low to moderate habitat functional capacity; and
- WL8.3 (0.03 ha) – Provides low to moderate hydrologic, low to moderate biochemical, and low habitat functional capacity.

Wetlands within the mine footprint, marsh and shallow open water wetlands, provide several hydrologic, biochemical, and habitat functions (Table 13.5-5), including: habitat availability for a variety of terrestrial species, including birds (e.g., migratory birds), amphibians and fish, water quality treatment, sediment and particulate retention, carbon sequestration and storage, nutrient cycling, and diversity of uncommon native plant communities. Additional details on functions provided by the wetlands directly affected as a result of the Project are detailed in Appendix 13-D.

On-site compensation will be used to offset impacts to wetland ecosystem extent and the associated loss of wetland function through the construction of new wetlands in the Reclamation and Closure phase and the natural formation of wetlands over time during Post-Closure. While wetland functions lost cannot be completely recreated, some wetland values and function can be restored within the Project footprint to offset losses to wetland functional capacity. The goal of wetland compensation and reclamation is to create healthy, functioning wetlands that provide habitat value and contribute to biodiversity of the reclaimed site, while achieving reclamation of wetland functions lost as a result of the Project.

Site reclamation practices and procedures are aimed at creating the most suitable conditions for the creation of a biologically diverse post-mine environment that takes into account ecosystem function and habitat objectives. The Ecological Restoration Plan outlines the proposed approach to progressive reclamation within the Project footprint (Chapter 33, Section 33.4.1.3). To compensate and replace the direct loss of 0.69 ha or 0.16% of the Terrestrial LSA, a total of 10 ha of wetland ecosystem will be created through on-site site reclamation and implementation of the Ecological Restoration Plan. A higher compensation ratio was also selected to support a no net loss of wetland functions, as some reclaimed areas may take longer to restore to desired function and the associated unknowns of the success of wetland offsetting functioning as planned and intended.

Through the creation of swamp, marsh, and shallow open water, it is anticipated that restored wetland will provide low to moderate hydrological and biological functional capacity; however, not all functions may be replaced.

13.6.7.3.3 Characterization of Residual Effects

The assessment of residual effects on wetland ecosystems 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.

Change in Wetland Ecosystem Extent Due to Clearing, Grubbing, Logging, and Soil Salvaging

The residual effect of a change in wetland ecosystem extent due to clearing, grubbing, logging, and soil salvaging is characterized as follows:

- Duration: Long-Term to Permanent, as loss of wetland extent will occur in Construction and Pre-Production and last until the Post-Closure phase as wetland extent and function are reclaimed in the Project footprint.
- Magnitude: Moderate, as there will be a 0.16% loss of wetland ecosystems within Terrestrial LSA due to development of the Project footprint.
- Geographic Extent: Discrete, as only wetlands within the Project footprint will be directly impacted and lost.
- Frequency: Once, the direct loss of wetland ecosystems within the Project footprint occurs only within the Construction phase of the Project.
- Reversibility: Reversible Long-Term to Irreversible, reclamation activities will restore wetland spatial extent; however, the function of reclaimed wetlands to perform in the same functional capacity as baseline conditions may be challenging to replicate and reclaimed areas may provide some or all of the functions affected as a result of the Project.
- Context: Low, wetlands affected by Project development have a low sensitivity and resilience to change, as time will be required for wetlands and their associated functional capacity to re-establish.

Determination of Significance

The residual effect on wetland ecosystems from the loss of wetland extent is considered not significant. Project effects to wetland spatial extent are limited in nature and occur only within the Project footprint, in which four (4) small wetlands are affected. This represents a loss of only 0.16% of wetlands in the Terrestrial LSA. The Project is not expected to result in considerable changes to wetland ecosystem measurement indicators of ecosystem abundance and distribution, compositional and structural changes, and changes in wetland function. No direct impacts to wetland ecosystems outside of the Project footprint are anticipated over the course of the Project. Any indirect effects that could occur to wetlands outside the Project footprint (e.g., from dust deposition, invasive plants, erosion and sedimentation, and dewatering into excavations) would be determined from follow-up and monitoring, and adaptive management measures to implement corrective actions would be developed as necessary based on that follow-up.

Compensation and reclamation of impacted wetlands and their functional capacity within the Project footprint is anticipated to result in a net gain of 4.22 ha of wetland habitat within the reclaimed mine area at the end of Project life, and provide various hydrological, biochemical, and habitat functions. A significant adverse residual effect on wetland ecosystems is defined as a Project-caused effect that results in a loss of wetland function that cannot be avoided, mitigated, or compensated in accordance with objectives of the Federal Policy on Wetland Conservation (Government of Canada, 1991). The net gain of 4.22 ha and a compensation ratio of 1:6 indicates no net loss to wetland ecosystem function and a residual effect that does not extend beyond the threshold of significance for wetland ecosystems. Therefore, in consideration of the above, the Project design to avoid impacts to wetlands, and planned mitigation, the residual effect of the Project on wetland ecosystems during all phases of the Project is rated not significant.

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 wetland ecosystem extent from Project development is considered to be moderate. Baseline conditions of wetland ecosystems within the Project footprint are well established, providing sufficient data to assess effects to wetland extent and allowing an understanding of the interaction between the Project and wetland ecosystems. Compensation and reclamation strategies proposed to offset impacts to wetland ecosystem extent and associated wetland functional capacity are expected to be moderate to high in effectiveness; however, changing climatic conditions could reduce confidence of mitigation success and effectiveness. Any indirect effects that could occur to wetlands outside the Project footprint (e.g., from dust deposition, invasive plants, erosion and sedimentation, and dewatering into excavations) would be determined from follow-up and monitoring. Adaptive management measures will be developed and implemented to address corrective actions, as necessary, based on the results of the follow-up program. Thus, the follow-up program to be implemented is expected to improve this level of confidence.

13.6.7.3.4 Summary of Residual Effects Assessment

Residual effects and the selected mitigation measures, characterization criteria, likelihood, significance determination, and confidence are summarized in Table 13.6-19. There are no significant residual effects to wetland ecosystems anticipated as a result of the Project.

Table 13.6-19: Summary of Residual Effects on Wetland Ecosystems

Residual Effect	Project Phases	Mitigation Measures	Summary of Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Change in Wetland Ecosystem Extent Due to Clearing, Grubbing, Logging, and Soil Salvaging	• Construction and Pre-Production • Reclamation and Closure	• Project design optimization • Implementation of the Ecological Restoration Plan • Reclamation of wetland ecosystems • Minimizing disturbance and cleared areas • Document new wetland areas observed in Project footprint • Monitor reclaimed wetlands and wetland function	Duration: Long-Term to Permanent Magnitude: Moderate Geographic Extent: Discrete Frequency: Once Reversibility: Reversible Long-Term to Irreversible Context: Low	Not Significant	Moderate

13.7 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, 2013a). The assessment of cumulative effects on landscape and ecosystem VCs requires that:

- The Project results in a residual adverse environmental effect on the landscape and ecosystem 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.

13.7.1 Overview of Residual Effects

An assessment of cumulative effects is required for landscapes and ecosystems VCs due to the possibility that potential Project residual effects on landscapes and ecosystems VCs may remain after implementation of proposed mitigation measures. For the purposes of the cumulative effects assessment, residual Project effects to be considered include:

- Change in abundance and distribution of avalanche chutes;
- Change in composition and structure of avalanche chutes;
- Change in grassland abundance and distribution;
- Change in grassland composition and structure due to vegetation removal and soil disturbance;
- Change in abundance and distribution of riparian habitat;
- Change in composition and structure of riparian habitat;
- Change in old growth and mature forest abundance and distribution; and
- Change in wetland ecosystem extent due to clearing, grubbing, logging, and soil salvaging.

Given the complexity of potentially interacting projects and activities, and that not all potential effects can be effectively quantified by the extent of the footprint alone, the coarse scale of the PEM data precludes much for the quantification or characterization of changes in composition or structure. Consequently, where residual Project effects were predicted to affect the composition or structure of landscapes and ecosystems VCs, these were considered to be approximately proportional to the extent of direct impacts of their footprints. Consequently, the list of potential cumulative effects was reduced to include only those associated with the abundance and distribution of the respective VC.

For the assessment of cumulative effects, residual effects for each landscapes and ecosystems VC were combined to evaluate the total potential change in a VC as it relates to changes in abundance, distribution, composition, and structure.

13.7.2 Assessment Boundaries

13.7.2.1 Spatial Boundaries

The assessment of cumulative effects for landscapes and ecosystems VCs was conducted at a regional scale and was confined to the Landscapes and Ecosystems RSA described in Section 13.3.3.1, which aligned with the study area used for the supplemental effects assessment addressing EV-CEMF requirements (MacDonald Hydrology Consultants Ltd., 2021a; MacDonald Hydrology Consultants, 2021b).

13.7.2.2 Temporal Boundaries

The temporal boundaries for the landscape and ecosystem cumulative effects assessment are the same as those for Project effects, as defined in Section 13.3.3.1.

The temporal cases used in the assessment of cumulative effects includes the following:

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 landscapes and ecosystems VCs is presented in the existing conditions of each VC (Section 13.5). 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; and
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.

The comparison of the Project Case with the Future Case allows the Project contribution to cumulative effects of all past, present, and reasonably foreseeable future projects and/or activities to be determined.

13.7.2.3 Administrative Boundaries

No additional administrative boundaries were considered in the cumulative effects assessment beyond those described in Section 13.3.3.3.

13.7.2.4 Technical Boundaries

The extents of landscapes and ecosystems VCs was determined using PEM for the Cranbrook TSA, which was prepared using raster-based data (i.e., the PEM is divided into a grid of equally sized cells, approximately 25 m x 25 m in size, for which each cell is attributed with a specific ecosystem type) and the mapped extent of VCs exhibits a pixelated appearance defined by the scale of the grid cells. Conversely, the footprints of the Project and reasonably foreseeable, future developments are derived from vector-based data (i.e., shapes are defined by actual boundaries of the mapped feature). To achieve consistency in methodology, the Project footprint, as well as the footprint of all past and reasonably foreseeable future developments, were converted to the same raster grid format. Given that natural systems and human development does not occur in such a pixelated, grid-based manner, the PEM data may not reflect the precise location, extent and/or attribution of ecosystems or activities. Further, as they are developed based on entirely different methodologies, discrepancies may exist between the PEM and Project TEM (KES, 2020a). Consequently, although the PEM data may be reasonably used for the general characterization of ecosystems and human activities across regional scales, it cannot be used for the evaluation of precise, site-specific impacts. Where substantial variation exists between the PEM and the Project TEM (KES, 2020a), the Project TEM was relied upon at the scale of the Landscapes and Ecosystems LSA.

Additionally, the potential future effects of fire, insect outbreak, and other spatially implicit future developments (i.e., where explicit boundaries of future disturbance are not yet proposed, but reasonably foreseeable), are derived based on a probabilistic modelling simulations (Appendix 13-E).

13.7.3 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.

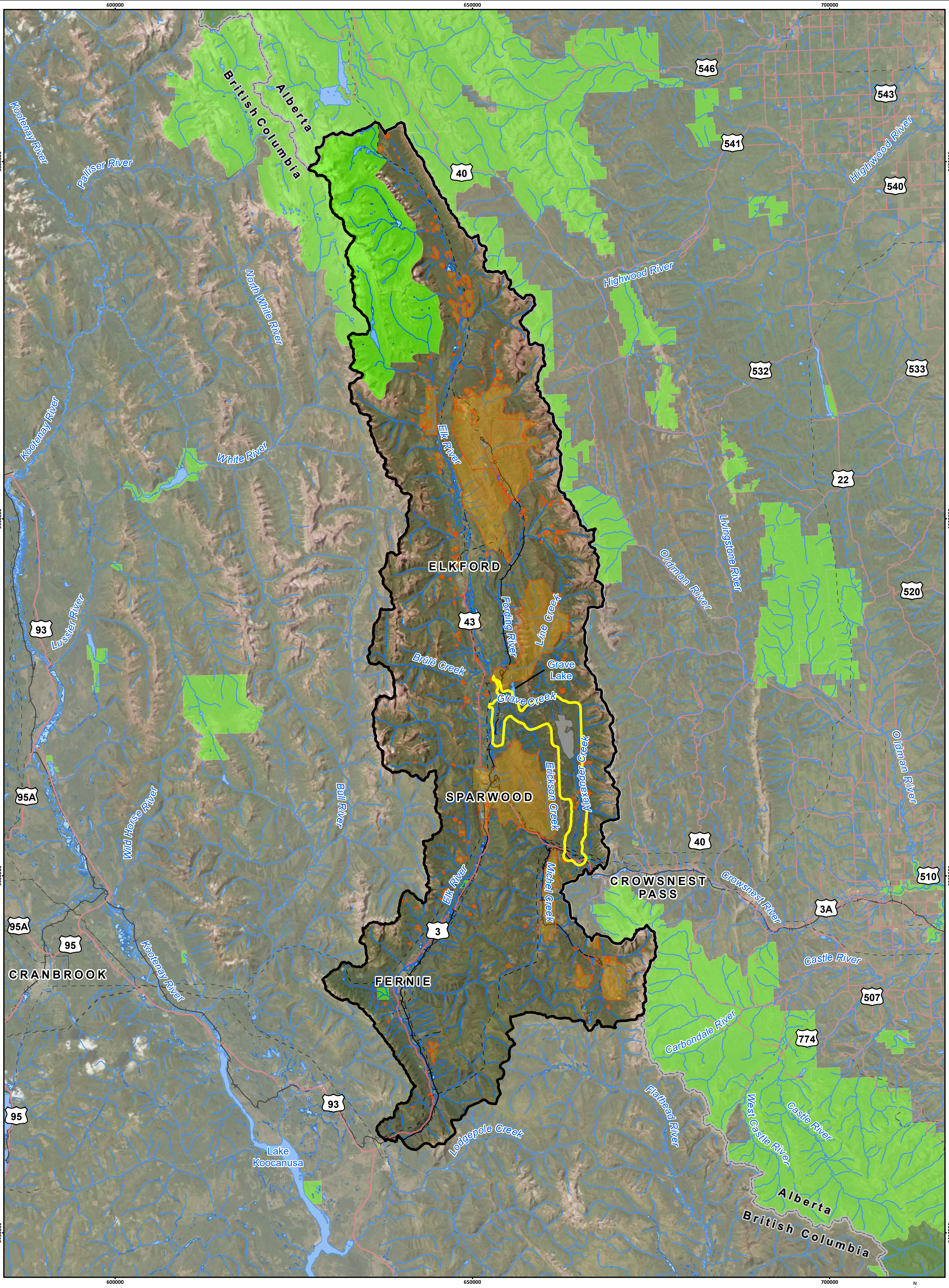
Several past, present, and reasonably foreseeable projects or activities are expected to interact with the landscapes and ecosystem VCs, which may result in a potential for adverse cumulative effects (Table 13.7-1). A map showing the location of the reasonably foreseeable future projects or activities is presented on Figure 13.7-1.

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:

Table 13.7-1: Project-Landscape Ecosystem VC Interactions Matrix for Potential Cumulative Effects

Past, Present, or Reasonably Foreseeable Future Projects or Activities	Ranking of Potential Cumulative Effect				
	Avalanche Chutes	Grasslands	Riparian Habitat	Old Growth and Mature Forests	Wetlands
Past or Present Projects and/or Activities that Have Been Carried Out					
Natural Resource Extraction – Mining (past)	II	II	II	II	II
Coal Mountain Operations	II	II	II	II	II
Elkview Operations	II	II	II	II	II
Line Creek Operations	II	II	II	II	II
Fording River Operations	II	II	II	II	II
Greenhills Operations	II	II	II	II	II
Kootenay West Mine	I	I	I	I	
Elkhorn Quarry West (Windermere Mining Operations)	I	I	I	I	I
Marten Phosphate Project	I	II	I	I	I
Energy - Elko Dam	I	I	III	III	I
Koocanusa Reservoir	I	I	III	III	II
Forestry	II	II	III	III	II
Energy - Pipelines	I	II	II	II	I
Energy - Electrical Transmission	I	II	II	II	I
Transportation	I	III	II	II	II
Recreation and Tourism	I	II	I	I	III
Commercial, Residential, and Industrial Use	I	III	II	II	III
Parks and Protected Areas	I	I	I	I	I
Agriculture	I	III	III	III	III
Natural Processes or Events	II	III	II	III	II
Reasonably Foreseeable Future Projects and/or Activities That Will Be Carried Out					
Michel Coal Project	II	II	II	III	I
Tent Mountain Mine	I	II	I	III	II
Fording River Extension Project	III	III	III	III	II
Bingay Main Project	III	I	III	III	II
Forestry	II	II	II	III	II
Climate Change	II	II	II	III	II
Natural Processes or Events	I	I	II	III	I

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 13.7-1
Reasonably Foreseeable Projects and Activities in the Landscapes and Ecosystems Regional Study Area

LEGEND

- Reasonably Foreseeable Future Projects and Activities
- Landscapes and Ecosystems Regional Study Area
- Landscapes and Ecosystems Local Study Area
- Crown Mountain Coking Coal Project
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/Alberta Border

0 10 20
Kilometres
Scale 1:500,000

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 ESRI.

Map Created By: LMM
Map Checked By: LKD
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

Project: 12-6231
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- 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.

13.7.4 Analysis of Cumulative Effects

13.7.4.1 Avalanche Chutes

Given their situation in high alpine environments on reasonably steep slopes, avalanche chutes are not typically adversely affected by dams or reservoirs; pipelines, electrical transmission lines, or transportation infrastructure; commercial, residential or industrial use; or agricultural development. Natural processes may be considered a neutral effect or potentially net benefit to avalanche chute ecosystems, as either the ecosystems are adapted to such events as forest fire, or that other processes such as landslides or avalanching may act to maintain or expand the area of avalanche chute ecosystems. Although forestry related development may overlap with avalanche chute ecosystems for access to planned timber harvest areas, loss is anticipated to be relatively low as avalanche chute ecosystems do not provide material volumes of merchantable timber. The remainder of the past and present activities affecting avalanche chute ecosystems are predominantly attributed to mining operations, particularly larger open pit mines and mine rock dumps located in high alpine locations, much like that planned for the Project. Reasonably foreseeable future mining developments will similarly affect avalanche chute ecosystems.

Forecasted modelling for the Elk Valley indicates that climate change is likely to result in reduced precipitation falling as snow, higher annual precipitation overall, and a substantial increase in average annual air temperature (Mackillop et al., 2018). Although regionally specific implications are not available, other studies have indicated that the effects of climate change on avalanche frequency and severity in British Columbia is uncertain, particularly as it relates to the extent of runout zones (Jamieson et al., 2017). Although species-specific responses to altered temperature and precipitation may be anticipated, the magnitude of change in species-specific responses and their interactions influencing the function of avalanche chute ecosystems cannot be accurately predicted. Given these uncertainties, the potential contribution of climate change to the cumulative effect on changes to the extent, composition, and structure of avalanche chute ecosystems cannot be accurately predicted at this time.

13.7.4.2 Grasslands

As previous discussed in Section 13.5.1.2, grasslands within the Landscapes and Ecosystems RSA have been previously affected by several factors, including large-scale open-pit mining within the Elk Valley, logging activities, livestock grazing, and settlements. An estimated total of 508 ha or 9% of grasslands in the Landscapes and Ecosystems RSA has been lost or modified between 1950 and 2014 (Golder, 2015), as outlined in Table 13.5-2. Additionally, fire (caused by both natural and anthropogenic sources) has historically been an important disturbance factor to grasslands. Wildfires benefit grasslands by removing litter, reducing biological soil crusts that may limit plant growth, and releasing nutrients back into the soil (MacKillop et al., 2018). Fire suppression activities has reduced both the patch size and abundance of grasslands in the Elk Valley (Demarchi et al., 2000; MGMT, 2010; Poole and Ayotte, 2019), and caused a greater abundance of young forests in previous grassland ecosystems (Kirby and Campbell, 1999). Generally speaking, the effects from those past and present activities on grasslands are encompassed in the existing (baseline) conditions for grasslands.

Forecasted modelling for the Elk Valley indicates that climate change is likely to result in reduced precipitation falling as snow, higher annual precipitation overall, and a substantial increase in average annual air temperature (EV-CEMF, 2018). Although regionally specific implications are not available, other studies have indicated that the effects of climate change on montane and alpine grassland ecosystems may result in increased aboveground biomass, and a decrease in overall species richness, due to the resistance of grassland vegetation communities to abrupt alterations in temperature and precipitation (Berauer et al., 2019). While model projections suggest a potential expansion of grassland ecosystems in response to increases in average annual temperature, the magnitude of change in species-specific responses and their interactions influencing the function of grassland ecosystems cannot be accurately predicted. Given these uncertainties, the potential contribution of climate change to the cumulative effect on changes to the extent, composition and structure of grassland ecosystems cannot be accurately predicted at this time.

13.7.4.3 Riparian Habitat

As they are typically designed to occur in lower relief positions where riparian habitat is also likely to occur, riparian habitat is more likely to be affected by dams and reservoirs; pipelines, electrical transmission lines, and transportation infrastructure; or commercial, residential industrial use, and agricultural development. Natural processes may be considered a neutral effect to riparian habitat, as either the ecosystems are maintained or shifted due to floods and landslides, or they are generally adapted to such events as forest fire. Given their general mandate for conservation of the natural environment and sustainable, low impact integration of human activity in the natural environment, areas of recreation and tourism, as well as parks and protected areas, are unlikely to have had an adverse effect on riparian habitat. Historic forestry practices are likely to have adversely affected riparian habitats from timber harvest in the Elk Valley over the past 100 years (Section 13.5.1.1; Teck, 2015; Mowat et al., 2018), well before the enactment of the Riparian Areas Protection Act in 1997 and the Riparian Areas Protection Regulation in 2004 that regulate the impact to riparian habitat. The remainder of the past and present activities affecting riparian habitat are predominantly attributed to mining operations, particularly larger open pit mines and mine rock dumps located in high alpine locations, much like that planned for the Project. The effects from those past and present activities to riparian habitat are encompassed in the existing (baseline) conditions for riparian habitat. Given the location of these mines in typically higher alpine contexts, riparian habitats are more likely to be smaller in extent, as they are more likely associated with higher order streams on steeper slopes that limit the extent of groundwater infiltration to adjacent ecosystems. Reasonably foreseeable future mining developments will have a similar effect on riparian habitats.

Forecasted modelling for the Elk Valley indicates that climate change is likely to result in higher annual precipitation overall and a substantial increase in average annual air temperature (EV-CEMF, 2018). Although an increase in precipitation may conceivably increase the volume of water flowing along drainages, this does not necessarily confer an increase in the extent of riparian habitat. An increase in total annual precipitation could be realized through increased duration or frequency of peak flows, but not necessarily a change in the extent of flooding and groundwater infiltration that drives the development of riparian habitats. Further, the interaction of increased temperature may result in earlier drawdown of the annual snowpack, or potentially increased rates of evapotranspiration that could adversely affect the extent of riparian habitat. Given these uncertainties, the potential contribution of climate change to the cumulative effect on changes to the extent, composition, and structure of riparian habitats in the Landscapes and Ecosystems RSA cannot be accurately predicted at this time.

13.7.4.4 Old Growth and Mature Forests

Although old growth and mature forests are likely to have been affected by past and present activities, the extent of effects is not readily predictable given a lack of available data. The effects of past and present projects and activities on old growth and mature forests are encompassed in the existing (baseline) conditions for this assessment, as a Base Case. Where located adjacent to (or surrounded by) forested ecosystems, the area occupied by past and present activities is likely to have overlapped with old growth and mature forests, or forests that may have had potential to develop to an old or mature structural stage. Further, although fire suppression for the protection of forest resources and human infrastructure in British Columbia commenced as early as 1847 with the enactment of the Bush Fires Act, the effect of fire suppression is unlikely to have caused material changes in the amount of old growth and mature forests in the Landscapes and Ecosystems RSA, as fire suppression disproportionately affects ecosystems with high fire return periods (i.e., Natural Disturbance Type 4) than forested sites (i.e., Natural Disturbance Type 3 or lower; Province of B.C., 1995). Similar to that predicted for other past and present activities, the Project has potential to act cumulatively with reasonably foreseeable future projects and activities to result in a reduction in the extent of old growth and mature forests in the Landscapes and Ecosystems RSA.

Forecasted modelling for the Elk Valley indicates that climate change is likely to result in a substantial increase in average annual air temperature (EV-CEMF, 2018). Although an exact mechanism was not defined, Kirchmeier-Young et al. (2018) demonstrated that the extent and severity of wildfires in British Columbia have increased over time, co-varying with anthropogenic climate change. Given that Canada's Forest Fire Weather Index System (Government of Canada, n.d.) identifies that the risk of ignition increases with reduced fuel moisture content (a product of increased air temperature, among other interacting factors), it is reasonable to assume that climate change influencing air temperature in the Elk Valley will result in an increased severity and extent of stand replacing fires. Given that stand replacing fires "reset" forest succession, where overlapping with old growth and mature forests, which are likely to have an abundance of fuel (e.g., deep organic soil horizons, large mature trees, snags and/or fallen deadwood), climate change is likely to result in a further loss of old growth and mature forests, although the extent of such loss cannot be predicted at this time.

13.7.4.5 Wetlands

As they are typically designed to occur in lower relief positions where large wetlands are also likely to occur, wetlands are more likely to be affected by dams and reservoirs; pipelines, electrical transmission lines, and transportation infrastructure; or commercial, residential industrial use, and agricultural development. Natural processes may be considered a neutral effect to wetlands, as either the ecosystems are maintained or shifted due to floods and landslides (particularly in higher slope positions), or they are generally adapted to such events as forest fire. Given their general mandate for conservation of the natural environment and sustainable, low impact integration of human activity in the natural environment, areas of recreation and tourism, as well as parks and protected areas, are unlikely to have had an adverse effect on wetlands. Further, historic forestry practices are unlikely to have adversely affected wetlands from timber harvest, as wetlands are not typically regarded as productive forested sites. The remainder of the past and present activities affecting wetlands are predominantly attributed to mining operations. Given the location of these mines in typically higher alpine contexts, wetlands are more likely to be smaller in extent, as they are more likely associated with slumps and seeps on slopes that limit the extent of groundwater infiltration to adjacent ecosystems. The effects from those past and present activities to wetlands are encompassed in the existing (baseline) conditions.

Forecasted modelling for the Elk Valley indicates that climate change is likely to result in higher annual precipitation overall and a substantial increase in average annual air temperature (EV-CEMF, 2018). Although an increase in precipitation may conceivably increase the volume of water flowing into wetlands, this does not necessarily confer an increase in the extent of wetland ecosystems. An increase in total annual precipitation could be realized through increased duration or frequency of peak flows, but not necessarily a change in the extent of flooding and groundwater infiltration that drives the development of wetlands. Further, the interaction of increased temperature may result in earlier drawdown of the annual snowpack, or potentially increased rates of evapotranspiration that could adversely affect the extent of wetlands. Given these uncertainties, the potential contribution of climate change to the cumulative effect on changes to the extent, composition, and structure of wetlands in the Landscapes and Ecosystems RSA cannot be accurately predicted at this time.

13.7.5 Mitigation for Cumulative Effects

The mitigation strategy developed for Project effects is also applicable to the Project's contribution to cumulative effects on landscapes and ecosystems VCs. As described in VC-specific mitigation measures, Project mitigation measures involve a combination of Project design features, procedures, and practices aimed at reducing or eliminating Project-related effects to landscape and ecosystem VCs.

Given that existing (i.e., present) and reasonably foreseeable future projects and activities are generally bound to the same legislative/regulatory frameworks as the Project, it is reasonable to expect that such activities will be subject to similar or analogous mitigation requirements specific to the respective industry. Present and reasonably foreseeable future projects and activities whose construction and operation overlap with the Project are subject to similar states of scientific knowledge regarding the mitigation of environmental effects. Consequently, it is reasonable to assume that potential effects of existing and reasonably foreseeable future projects and activities in the Landscapes and Ecosystems RSA are likely to be mitigated in a manner similar to that proposed for the Project.

For example, other surface mines and resource extraction activities are subject either to project-specific regulatory approvals or standardized practices that require development and implementation of an ecological restoration and reclamation plan. Consequently, it is reasonable to assume that such existing and reasonably foreseeable future mines will minimize the extent of loss of landscapes and ecosystems related VCs through ecological restoration and compensation activities within the Landscapes and Ecosystems RSA.

13.7.6 Residual Cumulative Effects

The Project and reasonably foreseeable developments have potential to result in a direct loss of area of landscapes and ecosystems VCs. The net change in area of each VC relative to the maximum potential development footprint for each of the assessment cases is provided in Table 13.7-2. Given that the extent of potential reclamation or restoration is not available for all reasonably foreseeable future projects or activities, the provided extent of potential effects is precautionary in nature and will be less at the time of the respective development's closure.

Table 13.7-2: Change in Landscape and Ecosystem VCs for the Base Case, Project Case, and Future Case in the Landscapes and Ecosystems RSA

Valued Component	Valued Component Area (ha)			Proportional Change Relative to the Base Case	
	Base Case	Project Case	Future Case	Base Case to Project Case	Base Case to Future Case
Avalanche Chutes	12,346.55	12,283.71	11,898.94	-0.51%	-3.63%
Grasslands	7,288.69	7,282.88	6,169.86	-0.08%	-15.35%
Riparian Habitat	26,696.80	26,603.10	23,487.11	-0.35%	-12.02%
Old Growth and Mature Forests	65,765.49	65,254.05	59,405.30	-0.78%	-9.67%
Wetlands	3,979.07	3,978.47	3,604.77	-0.02%	-9.41%

13.7.6.1 Avalanche Chutes

13.7.6.1.1 Characterization of Residual Cumulative Effects

The assessment of residual cumulative effects on avalanche chutes 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 cumulative effects include duration, magnitude, geographic extent, frequency, reversibility, and context, as defined in Chapter 5, Section 5.3.4.5. The residual cumulative effects on avalanche chutes are determined based on the same significance thresholds that were established for residual Project effects as outlined in Section 13.6.1.1.

Base Case

Avalanche chute ecosystems occupy an area of approximately 12,347 ha, or less than 4% of the Landscapes and Ecosystems RSA. The PEM data predict that avalanche chute ecosystems account for approximately 571 ha or 4% of the Landscapes and Ecosystems LSA, which varies by as much as 6% from that predicted in the Project TEM (i.e., 603 ha [Table 13.5-8]). Although differences in the predicted area exist, the magnitude of variation is considered to be immaterial for the purposes of this analysis (i.e., <1% of the Landscapes and Ecosystems LSA), and therefore the PEM mapping is considered to be reasonably accurate for the quantification of avalanche chute ecosystem extent at the regional scale.

Project Case

The Project footprint overlaps with 63 ha of avalanche chute ecosystems (Table 13.7-2), which is approximately 9% less than the extent of direct loss predicted using the Project TEM (i.e., 69 ha [Table 13.5-8]). Given the discrepancy between these data sources, the extent of avalanche chute ecosystems overlapping with the Project footprint is quantified using the Project TEM (Appendix 13-A), providing a precautionary estimate relative to the area predicted using the PEM data (i.e., 63 ha).

Additionally, the Project was predicted to result in additional change in abundance and/or composition and structure of avalanche chute ecosystems through removal of the respective start zones. Together with the extent of avalanche chute ecosystems predicted to occur in the Project footprint (i.e., 69 ha), the maximum extent of potential loss as a result of the Project could approach approximately 191 ha, or less than 2% of the extent of avalanche chute ecosystems in the Landscapes and Ecosystems RSA. In the event that the start zones are not completely removed, the partial alteration of the disturbance regime could also result in a change in the composition and/or structure of avalanche chute ecosystems downslope from the Project.

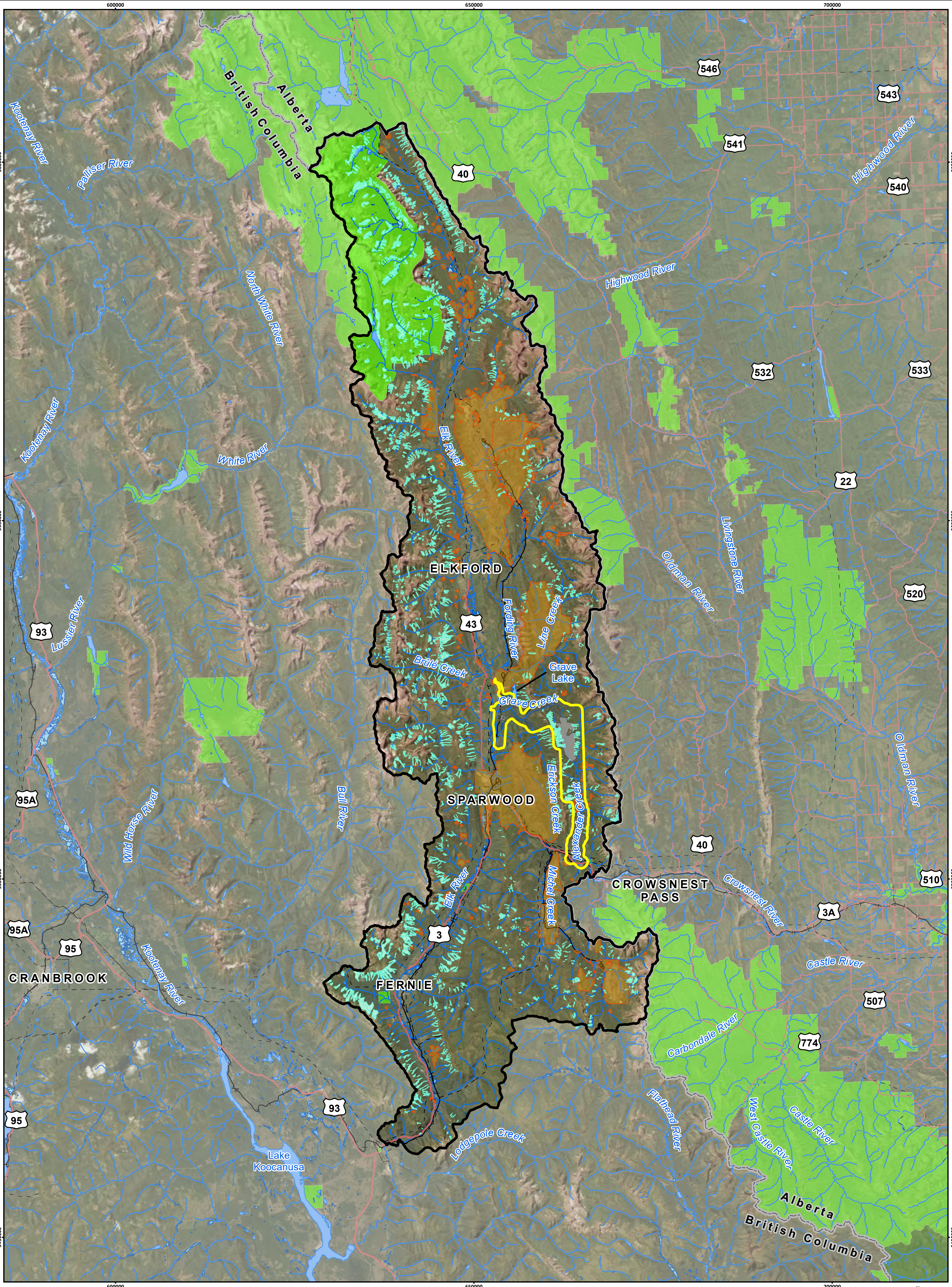
The majority of Project effects to avalanche chute ecosystems are attributed to the mine pits and the Mine Rock Storage Facility s and are not materially avoidable; however, the maximum extent of the Project footprint is conservative in nature. Specifically, the Project footprint includes an additional buffer from planned areas of disturbance to account for minor adjustments that could be required as determined throughout the Operations phase. Consequently, the maximum extent of potential effects to avalanche chute ecosystems is unlikely to occur.

Future Case

The Project and reasonably foreseeable future developments directly overlap with approximately 448 ha, or less than 4% (i.e., 448 ha of 12,347 ha) of the avalanche chute ecosystems present in the Landscapes and Ecosystems RSA (Figure 13.7-2). Corrected for potential underrepresentation in the PEM data by as much as 9%, the adjusted area of avalanche chute ecosystems overlapping with the Project footprint and reasonably foreseeable future developments is 492 ha.

Although it is probable that other reasonably foreseeable future developments could remove the start zones of adjacent, downslope avalanche chute ecosystems, the associated loss or change in composition and structure cannot be directly quantified given the limitations associated with the PEM data (Section 13.7.2.4). Alternatively, the extent of avalanche chute ecosystems downslope from the footprints of reasonably foreseeable future developments may be estimated from the same proportion of effects as that predicted under the Project Case. The extent of avalanche chute ecosystems overlapping with the Project footprint constituted approximately 36% of the total potential extent of loss or change in composition and structure (i.e., 69 ha out of 191 ha) of avalanche chute ecosystems in the LSA. Assuming a similar relationship for reasonably foreseeable, future developments in the Landscapes and Ecosystems RSA, then potentially as much as 1,367 ha, or 11% (i.e., 1,367 ha of 12,347 ha) of avalanche chute ecosystems may be affected under the Future Case.

Although contributing less than 3% (i.e., 1,283 ha of 44,279 ha) of the cumulative footprint of reasonably foreseeable future developments, the Project accounts for approximately 14% (i.e., 191 ha of 1,367 ha) of the cumulative effect to avalanche chute ecosystems. Consequently, the Project is considered to have a disproportionately higher potential effect on avalanche chute ecosystems in comparison to other reasonably foreseeable future developments.



Crown Mountain Coking Coal Project

Figure 13.7-2
Avalanche Chutes and Reasonably Foreseeable Projects and Activities in the Landscapes and Ecosystems Regional Study Area

LEGEND

- Avalanche Chutes
- Reasonably Foreseeable Future Projects and Activities
- Landscapes and Ecosystems Regional Study Area
- Landscapes and Ecosystems Local Study Area
- Crown Mountain Coking Coal Project
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/Alberta Border

0 10 20
Kilometres

N W E S

Scale 1:500,000

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 ESRI.

Map Created By: PR
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

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Project: 12-6231
Status: FINAL
Date: 2022-01-11

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13.7.6.1.2 Determination of Significance of Residual Cumulative Effects

Although other reasonably foreseeable future developments are anticipated to be subject to similar requirements for the mitigation of potential effects to avalanche chute ecosystems similar to those planned for the Project, it is also unlikely that other reasonably foreseeable future developments can completely avoid the direct loss of avalanche chute ecosystems, or the avalanche start zones from which the natural disturbance regimes originate. The maximum potential extent of cumulative loss or change in composition and structure of avalanche chute ecosystems is estimated to be 1,367 ha, or 11% of the area of the Landscapes and Ecosystems RSA. By extending the threshold of significance to the cumulative effects assessment, the residual effect of the Project acting cumulatively with the other past, present and reasonably foreseeable future developments would be moderate in magnitude (i.e., greater than 5% but less than 25% of the total VC area) and, therefore, not significant. The potential cumulative residual effect to the change in the abundance and distribution of avalanche chutes within the Landscapes and Ecosystem RSA is characterized as follows:

- Duration: Permanent, although reclamation activities will aim to restore herbaceous and shrub dominant vegetation types similar to avalanche chute ecosystems, the removal of avalanche chutes and their respective start zones which support their associated disturbance regimes cannot be replaced.
- Magnitude: Moderate, the Project acting cumulatively with past, present, and other reasonably foreseeable future developments will result in the loss of approximately 11% of the avalanche chute ecosystems in the Landscapes and Ecosystems RSA.
- Geographic Extent: Regional, the loss of avalanche chute ecosystems will be limited to the respective footprints of the Project as well as those of other reasonably foreseeable future developments and immediately downslope locations within the Landscapes and Ecosystems RSA.
- Frequency: Once, the removal of avalanche chute areas and/or their start zones can only occur once, but will be conducted incrementally and sequentially over the development of the Project and other reasonably foreseeable future developments.
- Reversibility: Irreversible, as it is unlikely that ecological restoration practices associated with the Project or past, present, or other reasonably foreseeable future developments will restore the disturbance regimes in reconstructed alpine communities, or retained avalanche chute ecosystems located outside of the Project footprint.
- Context: Neutral, although no ecosystem is resilient to complete removal, there is potential that some sliding activity may remain within retained avalanche chutes downslope from the Project and past, present, or other reasonably foreseeable future developments.

In light of the above, and in consideration of planned mitigation for the Project in addition to similar mitigation being assumed for other reasonably foreseeable future projects or activities, the residual cumulative environmental effects of the Project in combination with those of past, present, and reasonably foreseeable future projects or activities on avalanche chute ecosystems, during all phases of the Project, are considered not significant.

13.7.6.1.3 Likelihood and Confidence

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

Although it is reasonably certain that removal of avalanche chutes and associated start zones will be required, the full extent of loss associated with past, present, and reasonably foreseeable future developments cannot be accurately predicted with the information available. Consequently, the determination of significance is assessed to have only a moderate level of confidence; however, this level of confidence is reflected in the conservatism included in the predicted area of impact.

13.7.6.2 Grasslands

13.7.6.2.1 Characterization of Residual Cumulative Effects

The assessment of residual cumulative effects on grasslands 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 cumulative effects include duration, magnitude, geographic extent, frequency, reversibility, and context, as defined in Chapter 5, Section 5.3.4.5. The residual cumulative effects on grasslands are determined based on the same significance thresholds that were established for residual Project effects as outlined in Section 13.6.1.2.

Base Case

Grassland ecosystems occupy an area of approximately 6,812 ha, or 2% of the total area of the Landscapes and Ecosystems RSA. The PEM data predict that grassland ecosystems account for approximately 269 ha or 4% of the total area of the Landscapes and Ecosystems LSA, which varies by approximately 26% from that predicted in the Project TEM (i.e., 200 ha [Table 13.6-7]). Although differences in the predicted area exist, the magnitude of variation is considered to be immaterial for the purposes of this analysis (i.e., <1% of the total area of the Landscapes and Ecosystems LSA), and therefore the PEM mapping is considered to be reasonably accurate for the quantification of grassland ecosystem extent at the regional scale.

As discussed in Section 13.5.2.2.3, due to the relatively cool and moist climate in the region, grassland ecosystems predominate in areas of warm aspect, upper slope position, and well drained soils that produce conditions that are too dry to support forest ecosystems. While the overall proportion of grassland ecosystems within the Landscapes and Ecosystems RSA is similar to the Landscapes and Ecosystems LSA at 2% of total land area, grassland composition in the Landscapes and Ecosystems RSA is substantially different than the Landscapes and Ecosystems LSA. Grassland ecosystems dominated by graminoid species are more abundant relative to brushland type grassland ecosystems in the Landscapes and Ecosystems RSA, at proportions of approximately 60% and 40%, respectively. The elevation of grassland ecosystems is also distinctly different in the Landscapes and Ecosystems RSA relative to the Landscapes and Ecosystems LSA, with the largest proportion of grasslands found at elevations above 1,900 m asl in the Landscapes and Ecosystems RSA. Connectivity of grassland ecosystems is low in the Landscapes and Ecosystems RSA, similar to the Landscapes and Ecosystems LSA, with high elevation grasslands found on isolated peaks, the majority of which occur on a cluster of ridges north and east of Elkford.

Project Case

The Project footprint overlaps with approximately 6 ha of grasslands ecosystems (Table 13.7-2), which is approximately 47% less than the extent of direct loss predicted using the Project TEM (i.e., 13 ha [Table 13.6-7]). Given the discrepancy between these data sources, the extent of grassland ecosystems overlapping with the Project footprint is quantified using the Project TEM (Appendix 13-A), providing a conservative estimate relative to the area predicted using the PEM data (i.e., 5.81 ha).

The Project also was predicted to result in the indirect alteration of grassland ecosystems within an area of influence around the Project footprint as a result of vegetation removal and soil disturbance within the Project footprint. These residual effects are difficult to effectively quantify, as changes to grassland composition and structure adjacent to the Project footprint may range from an undetectable change at a microclimatic scale to a detectible and quantifiable alteration in the grassland composition and structure as a result of disturbance within the Project footprint.

The maximum extent of potential loss of grassland ecosystems as a result of the Project is approximately 12.47 ha, or 0.18% of the extent of grassland ecosystems available in the Landscapes and Ecosystems RSA. The majority of Project effects to grassland ecosystems are attributed to the mine pits and the Mine Rock Storage Facility and are not materially avoidable; however, the maximum extent of the Project footprint is conservative in nature. Specifically, the Project footprint includes an additional buffer from planned areas of disturbance to account for minor adjustments that could be required as determined throughout the Operations phase. Consequently, the maximum extent of potential effects to grassland ecosystems is unlikely to occur.

Future Case

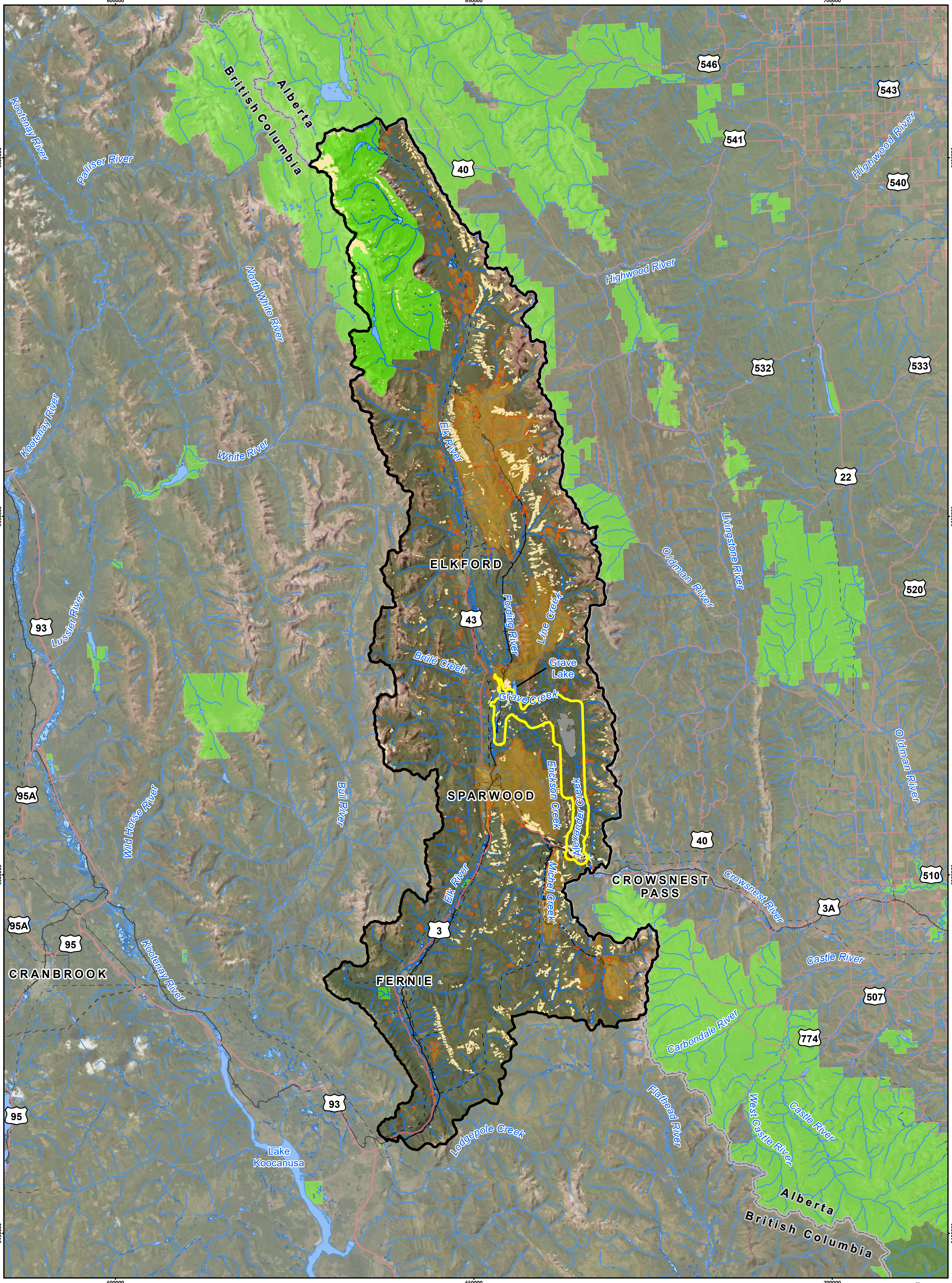
The Project and reasonably foreseeable future developments directly overlap with approximately 1,110 ha of grassland ecosystems present in the Landscapes and Ecosystems RSA. This represents approximately 16% (i.e., 1,110 ha of 6,812 ha) of grasslands within the Landscapes and Ecosystems RSA that may be affected under the Future Case (Figure 13.7-3).

Although it is probable that other reasonably foreseeable future developments could result in indirect changes to adjacent grassland ecosystems as a result of vegetation removal and soil disturbance, the associated loss or change in composition and structure cannot be directly quantified given the limitations associated with the PEM data (Section 13.7.2.4), as well as the challenges associated with quantifying potential indirect changes to grassland composition, as previously discussed.

Although contributing less than 3% (i.e., 1,283 ha of 44,279 ha) of the cumulative footprint of reasonably foreseeable future developments, the Project accounts for approximately 1% (i.e., 12 ha of 1,110 ha) of the cumulative effect to grassland ecosystems. Consequently, the Project contribution to cumulative environmental effects is considered to be relatively proportionate in comparison to the effects of other reasonably foreseeable future developments.

13.7.6.2.2 Determination of Significance of Residual Cumulative Effects

Although other reasonably foreseeable future developments are anticipated to be subject to similar requirements for the mitigation of potential effects to grassland ecosystems similar to those planned for the Project, it is also unlikely that other reasonably foreseeable future developments can completely avoid the direct loss of grassland ecosystems. The maximum potential extent of cumulative loss or change in composition and structure of grassland ecosystems is estimated to be 1,110 ha, or 16% of grasslands within the Landscapes and Ecosystems RSA. By extending the threshold of significance to the cumulative effects assessment, the residual effect of the Project acting cumulatively with the other past, present and reasonably foreseeable future developments is not anticipated to pose a risk to the long term viability and persistence of grassland ecosystems in the Landscapes and Ecosystems RSA and, therefore, is not significant.



Crown Mountain Coking Coal Project

Figure 13.7-3
Grasslands and Reasonably Foreseeable Projects and Activities in the Landscapes and Ecosystems Regional Study Area

LEGEND

- Grasslands
- Reasonably Foreseeable Future Projects and Activities
- Landscapes and Ecosystems Regional Study Area
- Landscapes and Ecosystems Local Study Area
- Crown Mountain Coking Coal Project
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/Alberta Border

0 10 20
Kilometres

Scale 1:500,000

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 ESRI.

Map Created By: PR
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

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The potential cumulative residual effect to the change in the abundance and distribution of grasslands within the Landscapes and Ecosystems RSA s is characterized as follows:

- Duration: Long Term to Permanent, as the direct loss of grasslands will occur through the advancement of construction of the Project and other past, present, and reasonably foreseeable future developments, although reclamation activities will aim to restore vegetation communities similar to grassland ecosystems upon closure.
- Magnitude: Moderate, the Project acting cumulatively with past, present, and other reasonably foreseeable future developments will result in the loss of approximately 16% of grassland ecosystems in the Landscapes and Ecosystems RSA; however, the Project contribution to cumulative effects on grassland ecosystems accounts for approximately 1% (i.e., 12 ha of 1,110 ha) compared to that of other reasonably foreseeable future developments in the Landscapes and Ecosystems RSA.
- Geographic Extent: Regional, the loss of grassland ecosystems will be limited to the respective footprints of the Project as well as those of other reasonably foreseeable future developments within the Landscapes and Ecosystems RSA.
- Frequency: Once, the removal of grasslands can only occur once, but will be conducted incrementally and sequentially over the development of the Project and other reasonably foreseeable future developments.
- Reversibility: Reversible Long-term to Irreversible, as ecological restoration practices associated with the Project or past, present, or other reasonably foreseeable future developments will restore the disturbance regimes in reconstructed grassland communities; however, where permanent infrastructure persists following restoration (e.g., access roads), the corresponding losses of grassland ecosystems in these areas will be permanent.
- Context: Low to Neutral, as grasslands affected by the Project and past, present, or other reasonably foreseeable future developments have a low sensitivity and resilience to change as it is anticipated to be slow to recover from disturbance.

In light of the above, and in consideration of planned mitigation for the Project in addition to similar mitigation being assumed for other reasonably foreseeable future projects or activities, the residual cumulative environmental effects of the Project in combination with those of past, present, and reasonably foreseeable future projects or activities on grassland ecosystems, during all phases of the Project, are considered not significant.

13.7.6.2.3 Likelihood and Confidence

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

Although it is reasonably certain that removal of grasslands will be required, the full extent of loss associated with past, present, and reasonably foreseeable future developments cannot be accurately predicted with the information available. Consequently, the determination of significance is assessed to have only a moderate level of confidence; however, this level of confidence is reflected in the conservatism included in the predicted area of impact.

13.7.6.3 Riparian Habitat

13.7.6.3.1 Characterization of Residual Cumulative Effects

The assessment of residual cumulative effects on riparian habitat 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 cumulative effects include duration, magnitude, geographic extent, frequency, reversibility, and context, as defined in Chapter 5, Section 5.3.4.5. The residual cumulative effects on riparian habitat are determined based on the same significance thresholds that were established for residual Project effects as outlined in Section 13.6.1.3.

Base Case

Riparian habitats occupy an area of approximately 26,697 ha, or approximately 8% of the Landscapes and Ecosystems RSA (i.e., 26,697 ha out of 350,919 ha). The PEM data predict that riparian habitats account for approximately 1,396 ha or 11% of the Landscapes and Ecosystems LSA, which is approximately 23% greater extent than that predicted in the Project TEM (i.e., 1,138 ha [Table 13.5-14]). Although this variation likely reflects uncertainty in the accuracy of predictive methods used to derive the PEM data, this variation may be attributable to inherent differences between the Landscapes and Ecosystems LSA and the greater Landscapes and Ecosystems RSA. Specifically, the Landscapes and Ecosystems LSA is predominantly located in an alpine environment[3], compared to the Landscapes and Ecosystems RSA, which is comprised of a greater proportion of Biogeoclimatic Zones typically associated with lowlands (i.e., Interior Cedar – Hemlock, Interior Douglas Fir and Montane Spruce; Table 13.5-1). These biogeoclimatic zones of lower relief and landforms are generally characterized by level to gently sloping grades where riparian areas are more likely to form around the dominant waterbodies (e.g., Elk River). Given that the Project TEM (Appendix 13-A) was prepared at a higher resolution and was based on field- verified reference data, this variation between the datasets suggests that the PEM data likely overestimate the extent of riparian habitat within the Landscapes and Ecosystems LSA.

Project Case

The Project footprint overlaps with approximately 94 ha of riparian habitat (Table 13.7-2), which is approximately 21% more than the extent of direct loss predicted using the Project TEM (i.e., 78 ha [Table 13.5-14]). For the same reasons provided under the Base Case, it is likely that the PEM data overestimate the extent of riparian habitat located within the Project footprint. Consequently, the predicted extent of overlap using the PEM data provides a precautionary estimate of the Project's proportional contribution to cumulative effects to riparian habitat in the Landscapes and Ecosystems RSA.

As mentioned previously (Section 13.6.5.3.2), an indirect loss of riparian habitat may occur outside of the Project footprint but within the Landscapes and Ecosystems LSA due to reductions in flow downstream of the Project footprint. Hydrologic modelling predicted that the Project has potential to reduce total flows in lower West Alexander Creek, whereupon it is likely that adjacent riparian areas will reduce in area as a result of the drawdown; however, the total extent cannot be quantified. A conservative estimate based on the total mapped extent in the Landscapes and Ecosystems LSA suggest that only 3% of riparian habitat

[3] The Engelmann Spruce – Subalpine Fir and Interior Mountain-heather Alpine Biogeoclimatic Zones occupy approximately 85% of the Project footprint, whereas the same Biogeoclimatic Zones occupy only 70% of the Landscapes and Ecosystems RSA.

downstream from the Project would be affected, comprising approximately 15% (i.e., 14 ha out of 92 ha) of the total potential effect of the Project on riparian habitat. By applying the same proportional effect to riparian habitat mapped using PEM data, the maximum potential downstream effect to riparian habitat would be 17 ha. Using the PEM data, the full extent of the Project's potential effect on riparian habitat within and downstream of the Project footprint would be 111 ha, equating to less than 1% of the extent of riparian habitat in the Landscapes and Ecosystems RSA.

The majority of Project activities contributing to the loss of riparian habitat may be attributed to the mine pits and Mine Rock Storage Facility, as well as the Main Sediment Pond prior to discharge to West Alexander Creek. However, the maximum extent of the Project footprint is conservative in nature and does not account for the extent of riparian habitat restored during the Post-Closure phase.

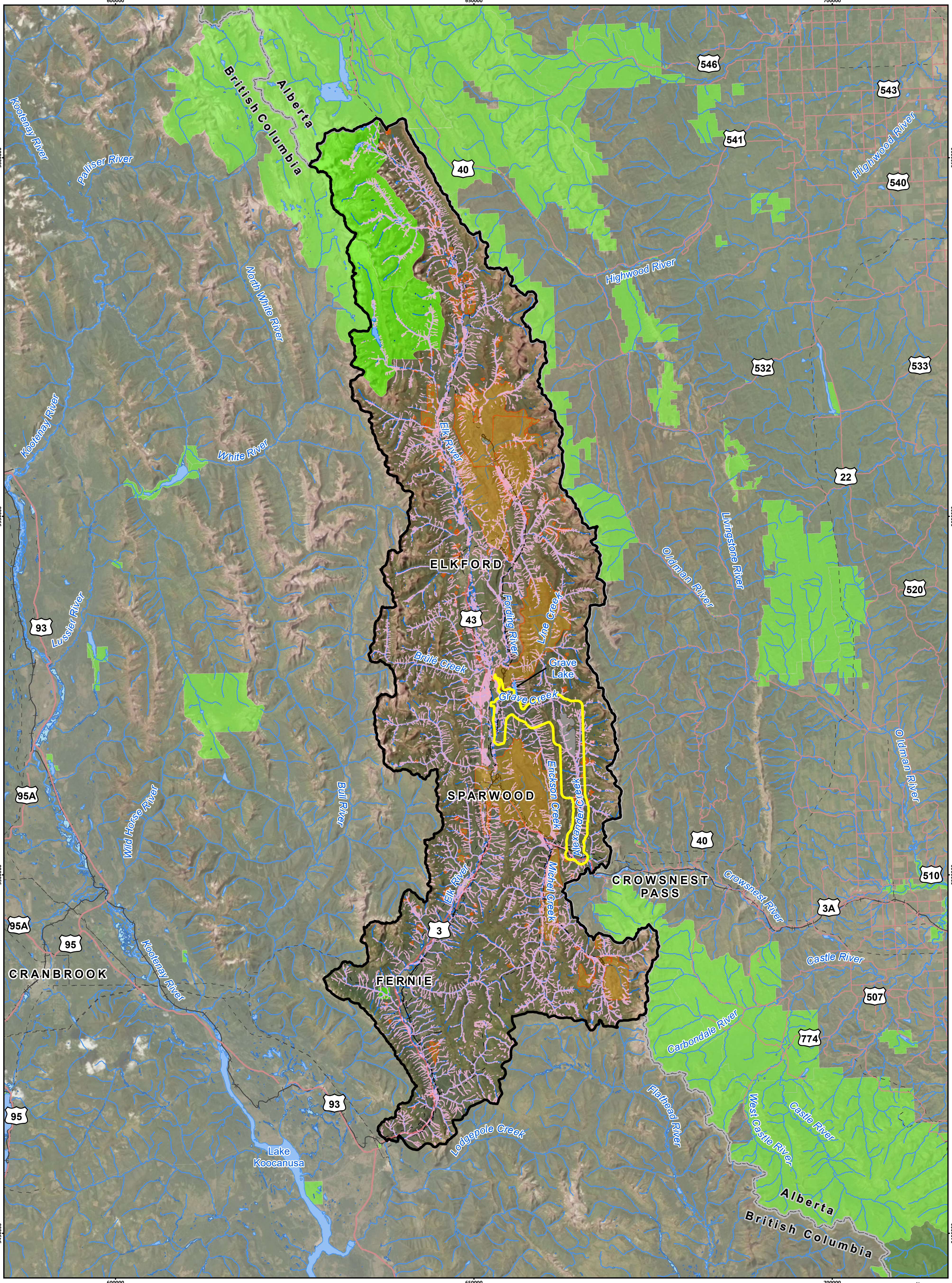
Considering that the PEM data potentially overestimate the extent of riparian habitat in the Project footprint, and that the residual effect of the Project does not include riparian habitat that will be restored during the Reclamation and Closure phase, the Project's relative contribution to effects on riparian habitat in the Landscapes and Ecosystems RSA is considered to be negligible.

Future Case

The Project, together with other reasonably foreseeable future developments, directly overlap with approximately 3,210 ha, or approximately 12% (i.e., 3,210 ha of 26,697 ha), of the riparian habitat present in the Landscapes and Ecosystems RSA (Figure 13.7-4).

Similar to that predicted for the Project (Section 13.6.5.3.2), it is possible that other reasonably foreseeable future developments could result in permanent alteration of downstream hydrological regimes. Although these downstream effects cannot be directly quantified given the limitations associated with the PEM data (Section 13.7.2.4), it may be assumed that a proportional effect similar to that predicted for the Project could occur. Given that approximately 15% (i.e., 14 ha of 92 ha total loss) of the Project's potential effect on riparian habitat was attributed to downstream effects from alteration of hydrological regimes, a similar proportional effect for the cumulative effect of all other reasonably foreseeable future developments would be 566 ha. Together with the direct loss due to overlap with their respective footprints, the cumulative effect of the Project as well as other reasonably foreseeable future developments on riparian habitat in the future case could be potentially as high as 3,776 ha, or 14% of the riparian habitat available in the Landscapes and Ecosystems RSA

The Project accounts for less than 1% (i.e., 111 ha of 26,697 ha) of the cumulative effect to riparian habitat, which is equivalent to its respective contribution to the cumulative footprint of reasonably foreseeable future developments (i.e., 1,283 ha of 305,918 ha) in the Landscapes and Ecosystems RSA. Consequently, the Project does not have a disproportionately higher potential effect on riparian habitat in comparison to other developments in the future case.



Crown Mountain Coking Coal Project

Figure 13.7-4
Riparian Habitat and Reasonably Foreseeable Projects and Activities in the Landscapes and Ecosystems Regional Study Area

LEGEND

- Riparian Habitat
- Reasonably Foreseeable Future Projects and Activities
- Landscapes and Ecosystems Regional Study Area
- Landscapes and Ecosystems Local Study Area
- Crown Mountain Coking Coal Project
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/Alberta Border

0 10 20
Kilometres
Scale 1:500,000

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 ESRI.

Map Created By: PR
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

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13.7.6.3.2 Determination of Significance of Residual Cumulative Effects

Although other past, present, or other reasonably foreseeable future developments are anticipated to be subject to similar requirements for the mitigation of potential effects to riparian habitat as those planned for the Project, it is also unlikely that all interacting developments will be able to completely avoid or mitigate effects to riparian habitats. The maximum potential extent of cumulative loss or change in composition and structure of riparian habitat is estimated to be 3,776 ha, or 14% of the area of riparian habitat available in the Landscapes and Ecosystems RSA. By extending the threshold of significance to the cumulative effects assessment, the residual effect of the Project acting cumulatively with the other past, present and reasonably foreseeable future developments would be moderate in magnitude (i.e., greater than 10% but less than 20% of the total VC area) and, therefore, not significant. . The potential cumulative residual effect to the change in the abundance and distribution of riparian habitat within the Landscapes and Ecosystems RSA is characterized as follows:

- Duration: Permanent, although reclamation activities will aim to restore effects to riparian habitat, it is unlikely that all areas can be replaced completely.
- Magnitude: Moderate, the Project acting cumulatively with past, present, and other reasonably foreseeable future developments will result in the loss of approximately 14% of the riparian habitat in the Landscapes and Ecosystems RSA.
- Geographic Extent: Regional, the loss of riparian habitat will be limited to the respective footprints of the Project, as well as those of other reasonably foreseeable future developments and immediate downstream locations within the Landscapes and Ecosystems RSA.
- Frequency: Once, the removal of riparian habitat can only occur once, but will be conducted incrementally and sequentially over the development of the Project and other reasonably foreseeable future developments.
- Reversibility: Irreversible, as it is unlikely that ecological restoration practices associated with the Project or past, present, or other reasonably foreseeable future developments will completely restore all affected waterbodies and their associated riparian habitat.
- Context: Low, given the dependence of riparian habitat on flooding or groundwater infiltration from adjacent waterbodies, such ecosystems are considered to be low in resilience to permanent change or removal of the associated waterbodies and their hydrological regimes.

In light of the above, and in consideration of planned mitigation for the Project in addition to similar mitigation being assumed for other reasonably foreseeable future projects or activities, the residual cumulative environmental effects of the Project in combination with those of past, present, and reasonably foreseeable future projects or activities on riparian habitat, during all phases of the Project, are considered not significant.

13.7.6.3.3 Likelihood and Confidence

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

Although it is reasonably certain that removal of riparian habitat and alteration of downstream flood regimes will be required, the full extent of loss associated with past, present, and reasonably foreseeable future developments cannot be accurately predicted with the information available. Consequently, the determination of significance is assessed to have only a moderate level of confidence; however, this level of confidence is reflected in the conservatism included in the predicted area of impact.

13.7.6.4 Old Growth and Mature Forests

13.7.6.4.1 Characterization of Residual Cumulative Effects

Base Case

Old growth and mature forests in the Landscapes and Ecosystems RSA occupy an area of approximately 65,765 ha (Table 13.7-2), or approximately 19% of the Landscapes and Ecosystems RSA (i.e., 65,765 ha out of 350,919 ha). The PEM data predict that old growth and mature forest account for approximately 2,851 ha or 22% of the Landscapes and Ecosystems LSA, which is approximately 43% of the extent of old growth and mature forests predicted using the Project TEM (i.e., 6,546 ha [Table 13.5-18]). Given this discrepancy (i.e., underrepresentation) between the Project TEM (Appendix 13-A) and the PEM data within the Landscapes and Ecosystems LSA, there is potential that the PEM data may underrepresent the extent of old growth and mature forests in the Landscapes and Ecosystems RSA.

MacDonald Hydrology Consultants Ltd. (2021; Appendix 13-F) predicted the extent of old growth and of old growth and mature forest, combined, to be 218 km^2 and 466 km^2, or 6% and 13% of the Landscapes and Ecosystems RSA, respectively. In comparison to the range of natural variation, both old growth forest, as well as old growth and mature forest combined, were found to have a moderate “hazard risk”, or that the existing extent of these ecosystems typically occur no more than 13.5% of the time (Holmes et al., 2018). Average patch size for the two measures considered by MacDonald Hydrology Consultants Ltd. (2021) were 7 ha and 22 ha, respectively.

Project Case

The Project footprint overlaps with approximately 511 ha of old growth and mature forests (Table 13.6-25), equal to less than one percent of the total extent of old growth and mature forest in the Landscapes and Ecosystems RSA. The predicted extent of old growth and mature forests affected under the Project Case is approximately half (i.e., 56%) of the extent predicted using the Project TEM (i.e., 910 ha [Table 13.5-9]); however, the proportional effect of the Project at the scale of the Landscapes and Ecosystems LSA remains approximately the same (i.e., 14% predicted using Project TEM vs. 18% predicted using the PEM data). Consequently, although differences in mapping accuracy of old growth and mature forests may exist between the Project TEM and the PEM data, the differences are consistent between the two sets of data and therefore the PEM data may still be used to estimate the extent of the Project’s effect on old growth and mature forest at the regional scale.

Under the Project Case (i.e., Scenario 1 in Appendix 13-F), MacDonald Hydrology Consultants Ltd. (2021) predicted that although the Project would potentially result in the removal of 1.2 km^2 and 1.9 km^2 of old growth and mature forest, the extents are negligible relative to the extents of old growth and mature forests in the Landscapes and Ecosystems RSA (i.e., 0.5% and 0.4%, respectively). Regardless of the loss due to the Project, recruitment of younger stands into old growth and mature forest age classes will increase their respective extent in the Landscapes and Ecosystems RSA throughout the phases of the Project. Given the anticipated recruitment to older age classes over time, the amount of old growth forest in the Project Case relative to the range of natural variation is anticipated to improve incrementally in all assessed BGC units. A similar, yet more pronounced pattern is predicted for old growth and mature forest combined, whereby the extent relative to the range of natural variation improves in some BGC units from a hazard rating of “Very High” to “Very Low”. That said, it is important to remember that this excludes natural disturbance, which is only considered under the Future Case. Patch size of old growth, and old growth and mature forest combined, was incrementally larger over the assessment period (i.e., 13.7 and 162.4 ha, respectively), equating a 90% and 638% increase from the Base Case, respectively.

The Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) provides for the restoration of approximately 484 ha of forested site types; however, the restored ecosystems are unlikely to achieve a structural stage equivalent to old growth or mature conditions for at least 150 years following the Post-Closure phase.

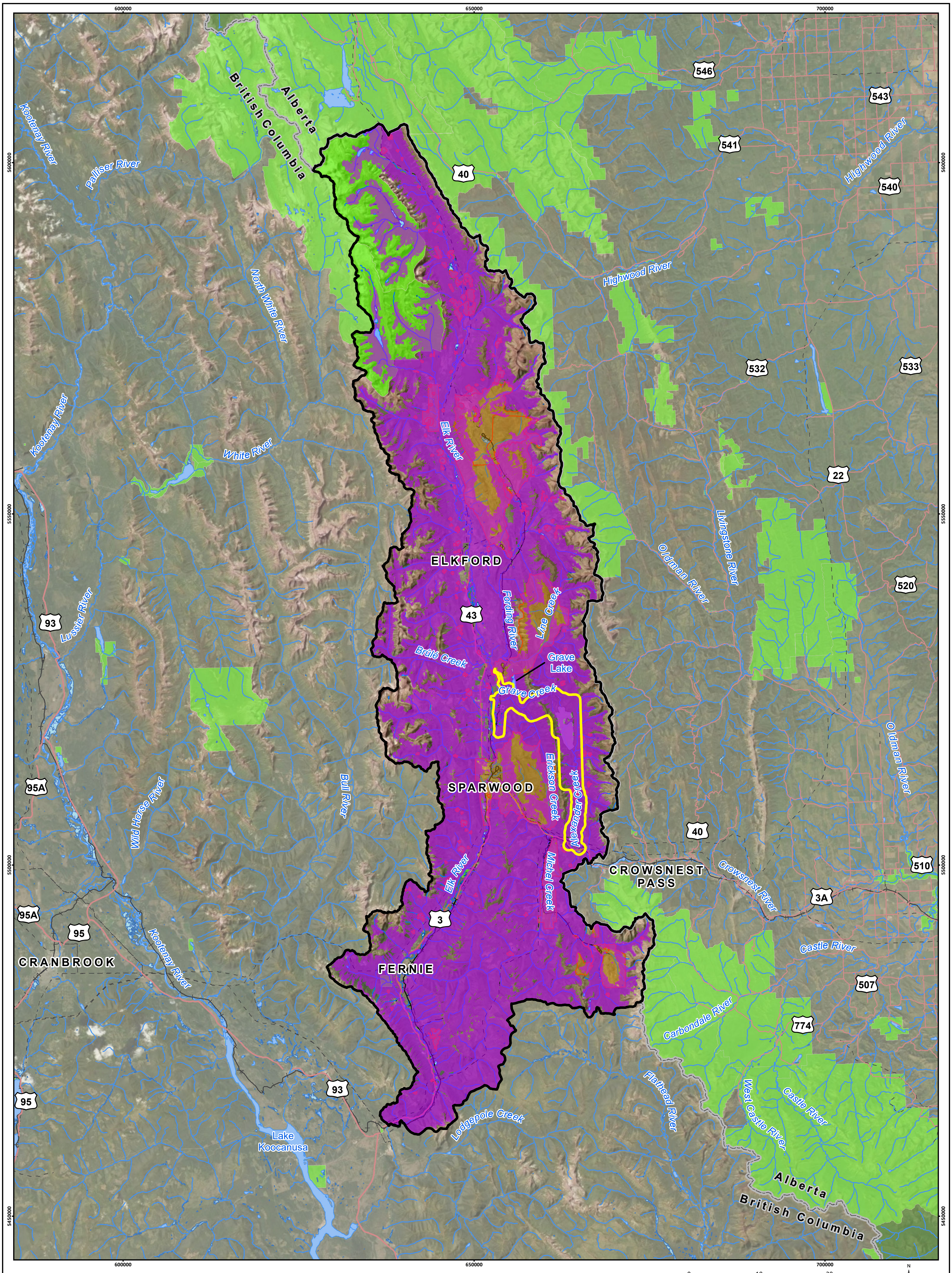
Future Case

The Project and other reasonably foreseeable future projects and activities overlap with approximately 6,360 ha, or approximately 10% (i.e., 6,360 ha of 65,765 ha), of the old growth and mature forests present in the Landscapes and Ecosystems RSA (Figure 13.7-5). The Project accounts for less than 1% (i.e., 511 ha of 65,765 ha) of the cumulative effect to old growth and mature forests, which is equivalent to its respective contribution to the cumulative footprint of reasonably foreseeable future projects and activities (i.e., 1,283 ha of 305,918 ha) in the Landscapes and Ecosystems RSA. Consequently, the Project does not have a disproportionately higher potential effect on old growth and mature forests in comparison to other developments in the future case.

Under the Future Case, MacDonald Hydrology Consultants Ltd. (2021) predicted a net increase in the extent of old growth forest, and old growth and mature forest combined, over the potential life of the Project; however, the greatest contributing factor limiting the extent of old growth and mature forest is natural disturbance (i.e., fire and insect outbreak). Given the recruitment from younger age classes, the amount of old growth forest and old growth and mature forest combined relative their respective range of natural variation exhibited similar but not necessarily as strong improvement as that predicted under the Project Case. When the contribution of natural disturbance is included (i.e., Scenario 3 in Appendix 13-F), the improvements in condition of old growth forest alone are generally immaterial; however, when considered in combination with mature forest, there still remains a substantial improvement from existing conditions over the assessment period. Incorporating reasonably foreseeable future projects and activities resulted in a slight reduction of the potential effect on patch size due to the Project alone (i.e., 86% and 614%, respectively). The greatest influence on the future state of patch size is due to natural disturbance, whereby the cumulative effect of reasonably foreseeable future projects and activities, together with natural disturbance, would exhibit a net change of -47% and 350% from the Base Case, respectively.

13.7.6.4.2 Determination of Significance of Residual Cumulative Effects

Although other reasonably foreseeable future developments are anticipated to be subject to similar requirements for the mitigation of potential effects to old growth and mature forests as those planned for the Project, it is also unlikely that all interacting developments will be able to completely avoid or mitigate effects. The maximum potential extent of cumulative loss (assuming incomplete or unsuccessful Post-Closure restoration) is estimated to be 6,360 ha, or 10% of the area of old growth and mature forest available in the Landscapes and Ecosystems RSA. By extending the threshold of significance to the cumulative effects assessment, the residual effect of the Project acting cumulatively with the other past, present and reasonably foreseeable future developments would be less than 15% across the Landscapes and Ecosystems RSA and, therefore, not significant.. The potential cumulative residual effect to the change in the abundance and distribution of old growth and mature forest within the Landscapes and Ecosystems RSA is characterized as follows:



Crown Mountain Coking Coal Project

Figure 13.7-5
Old Growth and Mature Forests and Reasonably Foreseeable Projects and Activities in the Landscapes and Ecosystems Regional Study Area

LEGEND

- Old Growth and Mature Forests
- Reasonably Foreseeable Future Projects and Activities
- Landscapes and Ecosystems Regional Study Area
- Landscapes and Ecosystems Local Study Area
- Crown Mountain Coking Coal Project
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Provincial Park/Protected Area
- National Park
- British Columbia/Alberta Border

Map Drawing Information:
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Map Created By: PR
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- Duration: Long-term, removal of old growth and mature forests will persist throughout the operational life of the Project and beyond, coinciding with the clearing of vegetation during the Construction and Pre-Production and Operations phases.
- Magnitude: Moderate, the Project acting cumulatively with past, present, and other reasonably foreseeable future projects and activities will result in the loss of approximately 10% of the old growth in the Landscapes and Ecosystems RSA, which may exceed localized thresholds. Regardless of the incremental loss caused by the Project and reasonably foreseeable future projects and activities, recruitment from younger age classes will sustain the extent of old growth and mature forest in the Landscapes and Ecosystems RSA.
- Geographic Extent: Regional, the loss of old growth and mature forests will be limited to the respective footprints of the Project, as well as that of other reasonably foreseeable future projects and activities.
- Frequency: Once, the removal of old growth and mature forests can only occur once, but will be conducted incrementally and sequentially over the development of the Project and other reasonably foreseeable future projects and activities.
- Reversibility: Reversible Long-term, although it is unlikely that ecological restoration practices associated with the Project and other reasonably foreseeable future projects and activities will completely restore all forested site types, and the time to achieve mature or old growth conditions exceeds the temporal boundaries of the assessment, recruitment from younger age classes will maintain or even potentially improve the extent of old growth and mature forest relative to the range of natural variation.
- Context: Neutral, although no ecosystem is resilient to clearing and removal, forested sites may still achieve a mature or old growth structural stage with time following restoration.

In light of the above, and in consideration of planned mitigation for the Project in addition to similar mitigation being assumed for other reasonably foreseeable future projects or activities, the residual cumulative environmental effects of the Project in combination with those of past, present, and reasonably foreseeable future projects or activities on old growth and mature forests, during all phases of the Project, are considered not significant.

13.7.6.4.3 Likelihood and Confidence

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

Although it is reasonably certain that removal of old growth and mature forests will be required, the full extent of loss associated with past, present, and reasonably foreseeable future projects and activities cannot be accurately predicted with the information available. Consequently, the determination of significance is assessed to have only a moderate level of confidence; however, this level of confidence is reflected in the conservatism included in the predicted area of impact.

13.7.6.5 Wetland Ecosystems

13.7.6.5.1 Characterization of Residual Cumulative Effects

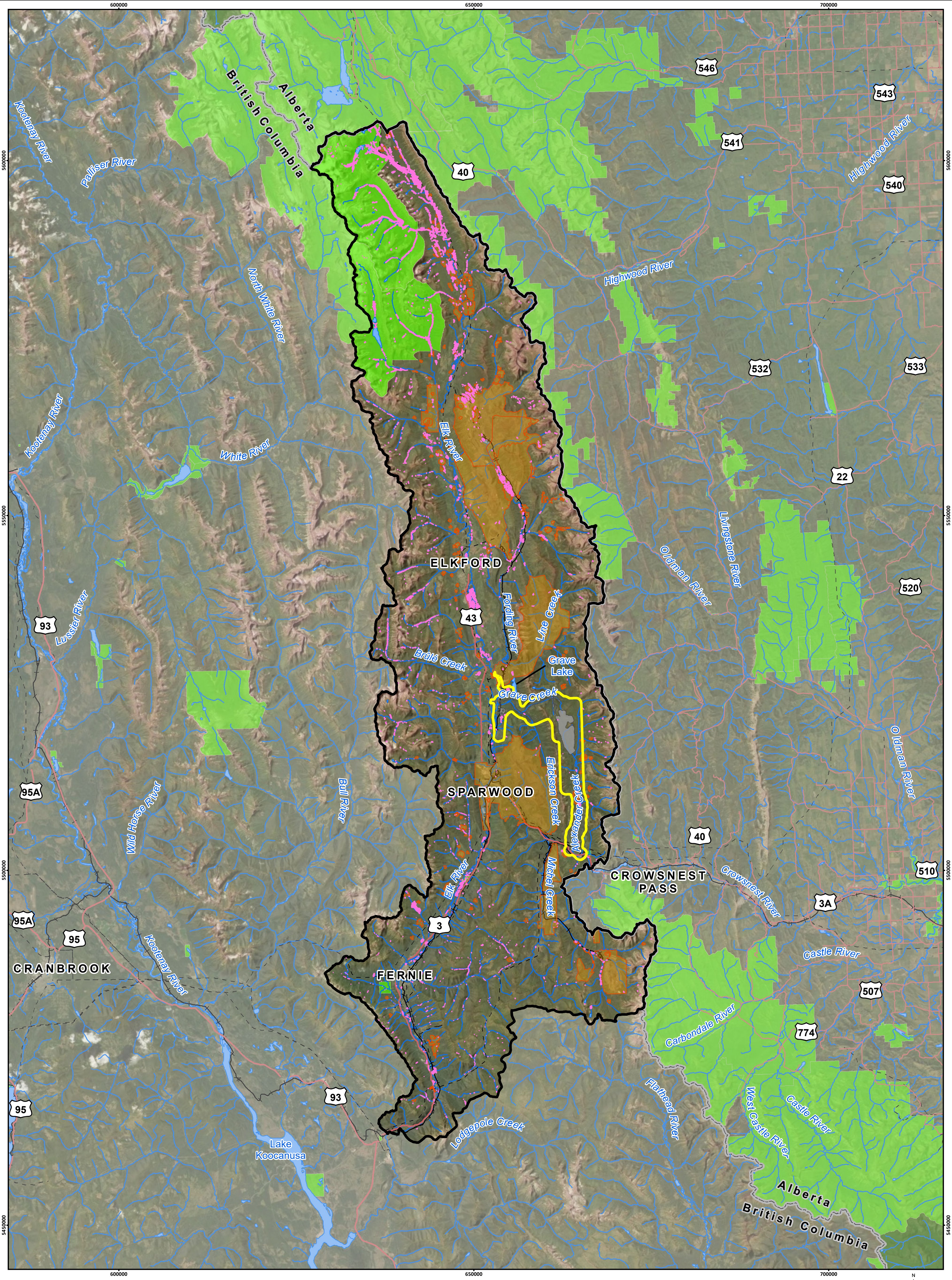
The assessment of residual cumulative effects on wetlands involves the consideration and evaluation of specific effects assessment criteria based on the degree (i.e., ‘level’) of potential Project effects. Similar to the Project effects assessment, the criteria used to characterize residual cumulative effects include duration, magnitude, geographic extent, frequency, reversibility, and context, as defined in Chapter 5, Section 5.3.4.5. The residual cumulative effects on wetlands are determined based on the same significance thresholds as were established for residual Project effects as outlined in Section 13.6.1.5.

Base Case

The PEM identifies that 3,979 ha of wetland ecosystems occupy the total area of the Landscapes and Ecosystems RSA, or approximately 1% of the Landscapes and Ecosystems RSA (i.e., 3,979 ha out of 350,919 ha) (Table 13.7-2; Figure 13.7-6). As part of the wetland baseline program, wetland ecosystems surveys were conducted at the scale of the Terrestrial LSA. A comparison of the wetlands documented through the wetland baseline surveys within the Terrestrial LSA included 39 ha of wetland, or less than 1% of the Terrestrial LSA. In comparison to the wetlands predicted through the PEM to occur in the Terrestrial LSA, wetlands accounted for approximately 64 ha, or less than 1% of the Terrestrial LSA. Within the Terrestrial LSA, the PEM predicts approximately 64% more area of wetland ecosystems than those documented through wetland baseline surveys. The difference in the predicted occurrence of wetlands in the Terrestrial LSA between the PEM and surveyed wetlands may be attributed to the spatial scale of the PEM data (i.e., lower resolution), as well as the baseline program documenting accessible wetlands within the local area through on-the-ground baseline surveys (i.e., areas of safety concern were not surveyed). The variation in the predicted wetland extent of PEM compared to the Terrestrial LSA wetland baseline surveys reflects uncertainty in the accuracy of predictive methods used to derive the PEM data; however, the variation may also be attributable to inherent differences between the study areas. Although the PEM predicts a greater number of wetlands within the Terrestrial LSA than the wetlands documented through baseline surveys, the PEM is considered to provide a reasonably accurate quantification of wetlands at a regional scale and provides a more precautionary approach to evaluating potential impacts to wetland ecosystems at the local and regional scales. As such, residual cumulative effects on wetlands are assessed using data from the PEM.

Regionally, wetland ecosystems typically occur along the bottom of creek and river valleys or lowland areas in conjunction with floodplains. Beyond these areas, wetlands are generally smaller and influenced by landscape variability, with some occurring in the shallow areas of lake margins. In the MSdw, wetland diversity is high and includes bogs, fens, swamps, marshes, and shallow open water wetlands (MacKillop et al., 2018). In the ESSFdk1, fens are the common wetland (MacKillop et al., 2018), with some marshes and swamps also occurring in this zone, along with alpine wetlands in cool high elevation areas.

Wetlands in the Elk Valley have been impacted by mining, land development, agriculture (including grazing), forestry, linear corridors (railway, roads), and recreational activities. These activities are likely to have reduced the abundance and distribution of wetlands, although the quantifiable impact from these activities is unknown. The introduction of invasive species to wetland habitats has likely also impacted wetland functionality and persistence, especially in areas easily accessible by human activity (e.g., forestry and backcountry roads; Walker and Millions, 2017). As noted in Section 13.5.1.5, wetland ecosystems in the Elk Valley have undergone disturbance due to changes in watercourses associated with wetlands, including changes such as diversions, siltation, and pollution (Cox and Cullington, 2009). Draining, diking, and conversion of wetlands has also taken place for urban development, resulting in changes to wetland ecosystem presence and persistence in the Elk Valley (Cox and Cullington, 2009). While it is challenging to speculate how much wetland in the Terrestrial RSA has been lost or altered due to past and present projects and activities, the effects of past and present projects and activities on wetlands are encompassed in the existing (baseline) conditions for wetland ecosystems.



Crown Mountain Coking Coal Project

Figure 13.7-6
Wetland Ecosystems and Reasonably Foreseeable Projects and Activities in the Landscapes and Ecosystems Regional Study Area

LEGEND

- Wetland Ecosystems
- Reasonably Foreseeable Future Projects and Activities
- Landscapes and Ecosystems Regional Study Area
- Landscapes and Ecosystems Local Study Area
- Crown Mountain Coking Coal Project
- Highway
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Provincial Park/Protected Area
- National Park
- British Columbia/Alberta Border

0 10 20
Kilometres
Scale 1:500,000

N W E S

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 ESRI.

Map Created By: PR
Map Checked By: BH
Map Coordinate System: NAD 1983 UTM Zone 11N

NWP Coal Canada Ltd

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Project Case

The PEM predicts that the Project footprint overlaps with 0.60 ha of wetland ecosystems, approximately 13% less than the loss predicted using the area of wetlands documented within the Project footprint through Project-specific baseline surveys (i.e., 0.69 ha). Given the area of the Project footprint surveyed for wetland ecosystems, and the confidence in the methods to characterize baseline conditions of wetland ecosystems, the extent of wetland ecosystems overlapping the Project footprint will be quantified using information gathered as part of wetland ecosystem baseline surveys. As the amount of wetland loss based on the baseline survey information is greater than the loss predicted by the PEM, this represents a conservative approach.

The Project is predicted to result in a residual effect to wetland ecosystems, specifically the change in wetland ecosystem extent due to the direct loss of wetland ecosystem extent (0.69 ha) and associated wetland functions within the Project footprint through Project development. The direct effect to wetlands will result in the loss of wetland vegetation and vegetation complexes, the loss of wetland soils, and loss of wetland catchment/drainage areas connected to Alexander Creek watershed. Wetlands directly affected by the Construction and Pre-Production phase include 0.27 ha of marsh and 0.42 ha of shallow open water. No sensitive or listed plant species or plant communities were documented in the wetlands anticipated to be directly lost as a result of the Project. Through ecological restoration in the Reclamation and Closure phase, several wetland areas will eventually be restored within the Project footprint, including 10 ha of wetland complexes consisting of marsh, swamp, and shallow open water wetlands. Restoration of wetlands will restore some affected wetland functions, but not all are likely to be restored to full functionality. No other residual effects on a change in wetland ecosystem function due to other Project activities are predicted in consideration of planned Project mitigation.

The maximum extent of potential loss of wetland ecosystems as a result of the Project is approximately 0.69 ha, or 0.02% of the extent of wetlands available in the Landscapes and Ecosystems RSA (i.e., 0.69 ha out of 3,979 ha of wetland available in the Landscapes and Ecosystems RSA). Project effects to wetland ecosystems within the Project footprint are attributed to land clearing, grubbing, logging, and soil salvaging during the Construction and Pre-Production phase, in particular, the clearing, development and mining at the East Pit and the land clearing and construction of the office/shop and Mine Rock Storage Facility.

Future Case

An analysis of the PEM data indicates that approximately 374 ha, or approximately 9.41% (i.e., 374 ha of 3,979 ha), of the wetland ecosystems present in the Landscapes and Ecosystems RSA overlap with the Project footprint and those of reasonably foreseeable future projects and activities (Figure 13.7-6).

It is therefore predicted that the cumulative loss of wetland due to the Project in combination with other reasonably foreseeable future projects and activities will be approximately 374 ha, or approximately 9.41% (i.e., 374 ha of 3,979 ha), of the wetland ecosystems present in the Landscapes and Ecosystems RSA. Wetland ecosystems within the Landscapes and Ecosystems RSA are anticipated to be affected by future mining projects, including Bingay Main Project, Fording River Expansion Project, and the Tent Mountain Mine, as well as future forestry activities in the Elk Valley (Table 13.7-2). These reasonably foreseeable future projects and activities, representing a predicted total footprint area of 44,279 ha, could reduce the abundance and distribution of wetland ecosystems in the Elk Valley, thereby resulting in cumulative effects to wetland ecosystems and associated wetland functions.

As noted for other landscapes and ecosystems VCs, forecasted modelling for the Elk Valley indicates that climate change is likely to result in reduced precipitation falling as snow, higher annual precipitation overall, and a substantial increase in average annual air temperature (EV-CEMF, 2018). As climate is an important factor in wetland formation (Moran and MacKenzie, 2004), changes in climactic conditions, such as changes in air temperature and precipitation, can result in effects on wetland ecosystems. Effects of climatic changes on wetland ecosystems could include reduced water supply, increased water temperature , increased potential for invasive species encroachment, and reduced wetland distribution and abundance for use by wildlife species (e.g., waterfowl) (Government of Canada, 2016). In the absence of regional specific climatic models and their potential impacts to wetland ecosystems in the Elk Valley, uncertainty exists on the potential extent of impacts and potential effects to wetlands as a result of climate change. As such, the potential contribution of climate change to the cumulative effect of wetland ecosystem extent in the Landscapes and Ecosystems RSA cannot be accurately predicted at this time, although it is reasonable to assume that those effects are unlikely to be considered negligible.

Although contributing less than 3% (i.e., 1,283 ha of 44,279 ha) of the footprints for reasonably foreseeable future projects and activities, the Project accounts for approximately 0.2% (0.69 ha of 374 ha) of the cumulative effect to wetland ecosystems in the Landscapes and Ecosystems RSA. Given this, the Project is expected to have a comparably lower potential effect on wetland ecosystems in the Landscapes and Ecosystems RSA than other reasonably foreseeable future projects and activities considered in the cumulative effects assessment.

Fen wetlands overlapped the most with the footprints of reasonably foreseeable, future projects and activities, comprising 57% of the wetland loss in the Landscapes and Ecosystems RSA. The wetland type comprising the next highest proportion of loss (i.e., 26%) includes the complex of potential treed swamps (i.e., site series 111/112, 112 and 112/113). The remainder of cumulative effects to wetlands (i.e., 17%) were divided among complexes of marsh, open water, and fen wetland types. For those areas of wetlands located adjacent to the Project and reasonably foreseeable future projects and activities, there is potential for wetland functions to be degraded or lost, depending on the nature of interaction and the relative value of each wetland for the affected functions. Although the magnitude of change in their respective functions cannot be quantified, it is reasonable to assume that potential cumulative effect on various wetland functions will at least equal if not surpass the potential effect associated with the proportional area of direct loss.

Similarly, the nature of potential indirect cumulative effects is not readily quantifiable, as not all reasonably foreseeable future projects and activities affect wetlands equally and proportionally to the extent of their area of disturbance. For example, projects or activities that regulate water levels/flow are more likely to affect larger downstream wetlands within the flood plain of the affected waterbody, or upstream through increased stabilization of water levels upstream. These wetlands are likely far larger and more numerous than isolated fens located at groundwater seeps midslope in the ESSF that are more likely to be affected by some of the mining projects.

13.7.6.5.2 Determination of Significance of Residual Cumulative Effects

The effect of the Project on the potential extent of wetland loss, 0.69 ha, has the potential to combine with those effects of other reasonably foreseeable future projects and activities in the Landscapes and Ecosystems RSA to produce a potential cumulative effect to wetland ecosystems. The predicted maximum potential extent of change in wetland because of the Project in combination with other reasonably foreseeable future projects and activities without considering mitigation is estimated to be 374 ha (or approximately 9.41% of the total area of wetland available in the Landscapes and Ecosystems RSA), although the Project contribution to that cumulative loss is only 0.69 ha (or approximately 0.02% of the area of wetlands available in the Landscapes and Ecosystems RSA). In the Landscapes and Ecosystems RSA, it is unlikely that future projects and activities can completely avoid direct impacts to wetland ecosystems. As such, for the purposes of the cumulative effects assessment, it is assumed that reasonably foreseeable projects and activities will mitigate potential adverse effects to wetland ecosystems in a similar manner as those measures planned for the Project, presumably reducing the overall predicted extent of wetland loss to less than 374 ha, but likely not eliminating residual impacts to wetlands altogether.

The potential cumulative residual effect to the change in wetland extents within the Landscapes and Ecosystems RSA is characterized as follows:

- Duration: Long-term to Permanent, as wetlands directly loss through construction and development of reasonably foreseeable future projects and activities will result in a loss of wetland ecosystems persisting until impacted wetlands are restored through reclamation, and wetland functions re-establish as a result of restoration activities.
- Magnitude: Moderate, the Project acting cumulatively with past, present, and other reasonably foreseeable future developments will result in the loss of approximately 9.41% of wetland ecosystems in the Landscapes and Ecosystems RSA; however, the Project contribution to cumulative effects on wetland ecosystems accounts for approximately 0.02% (i.e., 0.69 ha of 3,979 ha) of the potential overlap between wetlands and reasonably foreseeable future projects and activities.
- Geographic Extent: Regional, the loss of wetland ecosystems will be limited to the overlap of the Project and other reasonably foreseeable future projects and activities within the Landscapes and Ecosystems RSA.
- Frequency: Once, the direct loss of wetland ecosystems in the Landscapes and Ecosystems RSA will occur as reasonably foreseeable future projects and activities are constructed or carried out across the Landscapes and Ecosystems RSA.
- Reversibility: Reversible Long-term to Irreversible, as ecological restoration activities anticipated to occur through mitigation and offsetting strategies associated with the Project and past, present, and reasonably foreseeable future projects and activities will result in reclaimed wetland ecosystems in the Landscapes and Ecosystems RSA; however, some wetland functions lost through direct removal of wetland ecosystems may be challenging to replicate ,and reclaimed areas may only provide some, not all, of affected wetland functions.
- Context: Low, wetlands affected by the Project and past, present, and reasonably foreseeable future projects and activities have a low sensitivity and resilience to change, as restoration of wetland ecosystem and related function capacity will take several years to re-establish and meet restoration objectives.

In light of the above cumulative residual effects characterization, and given the anticipated mitigation and restoration activities that may occur through development of reasonably foreseeable future projects and activities, the residual cumulative effects to wetland ecosystems in the Landscapes and Ecosystems RSA are not anticipated to affect the long-term viability of wetland ecosystems in the Elk Valley. Assuming wetland ecosystems and their functional capacity impacted by future projects and activities are restored as per the objectives of the Federal Policy on Wetland Conservation (Government of Canada, 1991), the residual cumulative environmental effects of the Project in combination with those of past, present, and reasonably foreseeable future projects or activities on wetland ecosystems, during all phases of the Project, are considered not significant.

13.7.6.5.3 Likelihood and Confidence

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

The confidence in the characterization of residual cumulative effects to wetland ecosystems from the Project and past, present, and reasonably foreseeable future projects and activities is considered to be moderate. As with other cumulative effects for landscapes and ecosystem VCs, the full extent of wetland ecosystem loss (or change) associated with past, present, and reasonably foreseeable future projects and activities cannot be accurately predicted due to insufficient data to fully quantify previous and future disturbance to wetland ecosystems at a regional scale. Impacts to wetland ecosystems have occurred in the Elk Valley as a result of past and present projects and activities, and it is likely that impacts to wetland ecosystems will continue to occur should reasonably foreseeable future projects and activities be carried out in the Landscapes and Ecosystems RSA. The full potential effects to past, present, and future projects and activities is not fully understood at this time.

13.7.7 Summary of Cumulative Effects Assessment

Given the complexity of potentially interacting projects and activities, and that not all potential effects can be effectively quantified by the extent of the footprint alone, the coarse scale of the PEM data precludes much for the quantification or characterization of changes in composition or structure. Consequently, where residual Project effects were predicted to affect the composition or structure of landscapes and ecosystems VCs, these were considered to be approximately proportional to the extent of direct impacts of their footprints. The list of potential cumulative effects was therefore reduced to include only those associated with the abundance and distribution of the respective VC.

Using the area of overlap between the identified VCs and the footprints of the Projects, the magnitude of potential cumulative effects was characterized to the extent practical; however, not all potential cumulative effects could be quantified. Where applicable, the anticipated potential effect of climate change and other indirect cumulative effects were described qualitatively. The cumulative effects assessment assumed that potential effects of existing and reasonably foreseeable future projects and activities in the Landscapes and Ecosystems RSA are likely to be mitigated in a manner similar to that proposed for the Project. Consequently, the described extent of cumulative effects (whether qualitative or quantitative) provides a conservative estimate of the residual effects, as it does not factor the ecological restoration that would occur during the closure phases of the Project and reasonably foreseeable future projects and activities.

The Project's respective contribution to the potential cumulative effects was generally found to be proportional to its contribution to the footprint of reasonably foreseeable future projects and activities (Table 13.7-3). There are no residual cumulative effects found to be significant; however, many were characterized to be of moderate magnitude and to have some degree of irreversibility.

Table 13.7-3: Summary of Cumulative Effects on Landscapes and Ecosystems VCs

Residual Cumulative Effect	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Change in Abundance and Distribution of Avalanche Chutes	• Project design optimization • Minimizing disturbance and cleared areas • Limit the frequency of use and explosive potential for all explosives • Construct diversion berms and/or retention walls where avalanche chutes runout on to the Project footprint • Schedule blasting during periods of relatively high stability in the snowpack, when feasible	Duration: Permanent Magnitude: Moderate Geographic Extent: Regional Frequency: Once Reversibility: Irreversible Context: Neutral	Not Significant	Moderate
Change in Grassland Abundance and Distribution	• Project design optimization • Minimizing disturbance and cleared areas • Establish exclusion / "no work" zones and setback buffers • Education and training • Implementation of the Soil Management Plan • Implementation of the Erosion and Sediment Control Plan	Duration: Long-term to Permanent Magnitude: Moderate Geographic Extent: Regional Frequency: Once Reversibility: Reversible long-term to Irreversible Context: Low to Neutral	Not Significant	Moderate
Change in Abundance and Distribution of Riparian Habitat	• Project design optimization • Implementation of the Ecological Restoration Plan • Minimizing disturbance and cleared areas • Project design optimization • Minimum design standards for water management infrastructure • Energy dissipation devices	Duration: Permanent Magnitude: Moderate Geographic Extent: Regional Frequency: Once Reversibility: Irreversible Context: Low	Not Significant	Moderate

Residual Cumulative Effect	Mitigation Measures	Summary of Cumulative Residual Effects Characterization	Significance (Significant, Not Significant)	Confidence (High, Moderate, Low)
Change in Old Growth and Mature Forest Abundance and Distribution	• Project design optimization • Delay construction areas of mine components until ready to mine	Duration: Long-term Magnitude: Moderate Geographic Extent: Regional Frequency: Once Reversibility: Reversible long-term Context: Neutral	Not Significant	Moderate
Change in Wetland Ecosystem Extent	• Project design optimization • Implementation of Ecological Restoration Plan • Reclamation of wetland ecosystems • Minimizing disturbance and cleared areas • Document new wetland areas observed in Project footprint • Monitor reclaimed wetlands and wetland function	Duration: Long-term to Permanent Magnitude: Moderate Geographic Extent: Regional Frequency: Once Reversibility: Reversible long-term to Irreversible Context: Low	Not Significant	Moderate

13.8 Follow-up Strategy

As defined in Canadian Environmental Assessment Act 2012, a follow-up program is used to verify environmental effects predictions or to verify the effectiveness of mitigation measures; general environmental assessment practice is to define a follow-up program where there is uncertainty in the level of confidence (i.e., low to moderate confidence) in the significance predictions or surrounding the effectiveness of mitigation. Where a follow-up program identifies that environmental effects differ from those predicted in the effects assessment, or where mitigation measures prove to be ineffective, alternative strategies are developed to adaptively manage the Project's effects on VCs of landscapes and ecosystems.

Residual effects and cumulative effects for landscapes and ecosystems VCs for which uncertainty was identified are summarized in Table 13.8-1.

Table 13.8-1: Summary of the Confidence for Residual Project and Cumulative Effects on Landscapes and Ecosystems VCs

Valued Component	Residual Effect	Confidence Ranking		Follow-up Program Required?
		Project Effects	Cumulative Effects	
Avalanche Chutes	Change in Abundance and Distribution	Moderate	Moderate	Yes
	Change in Composition and Structure	Moderate		

Valued Component	Residual Effect	Confidence Ranking		Follow-up Program Required?
		Project Effects	Cumulative Effects	
Grasslands	Change in Abundance and Distribution	Moderate	Moderate	Yes
	Change in Composition and Structure	Moderate		
Riparian Habitat	Change in Abundance and Distribution	Moderate	Moderate	Yes
	Change in Composition and Structure	Moderate		
Old Growth and Mature Forest	Change in Abundance and Distribution	Moderate	Moderate	Yes
	Change in Composition and Structure	High		
Wetland Ecosystems	Change in Wetland Ecosystem Extent	Moderate	Moderate	Yes

13.8.1 Proposed Approach to Follow-up

The proposed follow-up program for landscapes and ecosystems VCs is presented in Table 13.8-2.

Species composition and abiotic factors (e.g., dust, groundwater elevation) shall be monitored at permanent fixed survey locations with sufficient frequency and intervals between documentation events to detect material variation affecting ecosystems and plant communities over the implementation period. For example, vegetation composition might be characterized between one and three times per year depending on the duration of the growing season, whereas dustfall may be assessed monthly or annually (as a single aggregate sample).

The follow-up program outlined in the Vegetation and Ecosystems Management and Monitoring Plan (Chapter 33, Section 33.4.1.11) will:

- Describe/quantify (where appropriate) the Project activities conducted over the preceding year, including but not limited to the extent of clearing, volume of material mined, and type of infrastructure installed;
- Describe the mitigation measures implemented (including their maintenance, alteration, and/or removal) over the preceding year;
- Provide the results of monitoring conducted in the preceding year;
- Identify deficiencies in mitigation measures or monitoring protocols as well as their proposed resolution; and
- Verify the accuracy of predictions and conclusions provided in this environmental assessment.

Mitigation and monitoring strategies proposed for the landscapes and ecosystem VCs will be updated over the course of the Project, as appropriate, to maintain consistency with provincial and federal regulatory requirements, best management practices, and scientific methods and research techniques. Throughout the life of the Project, material amendments to mitigation measures and monitoring programs will be carried out in collaboration with Indigenous communities, provincial and federal agencies, and key stakeholders.

Table 13.8-2: Follow-up and Monitoring Measures and Timing/Duration by Valued Component

Valued Component	Follow-up and Monitoring Measure	Timing (Phase)	Timing (Years)
Avalanche Chutes	Extent of the VC area overlapping with Project footprint activities, including the extent of rare and sensitive ecosystems	Construction and Pre-Production and Operations phases	Prior to disturbance only
	Extent of the VC area overlapping with occurrences of weeds and invasive, non-native species, as well as the area of implemented control/treatment measures	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Extent of the VC area overlapping with spills or releases of deleterious substances including sediment-laden water	Only required where overlapping with reportable spills or releases	As applicable
	Plant species composition as well as the rate of deposition (i.e., mass/year/hectare), particle size analysis, and contaminant analysis for dustfall at regular intervals up to 100 m from the edge of clearing from the Project	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Delineation of the extent of post-slide avalanche fields (adjacent/contiguous with the Project footprint) following avalanche control or operational blasting events	Construction and Pre-Production and Operations phases	Following avalanche control or operational blasting events only
Grasslands	Extent of the VC area overlapping with Project footprint activities, including the extent of rare and sensitive ecosystems (e.g., Gg12 ecological community)	Construction and Pre-Production and Operations phases	Prior to disturbance only
	Extent of the VC area overlapping with occurrences of weeds and invasive, non-native species, as well as the area of implemented control/treatment measures	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Extent of the VC area overlapping with spills or releases of deleterious substances including sediment-laden water	Only required where overlapping with reportable spills or releases	As applicable
	Plant species composition as well as the rate of deposition (i.e., mass/year/hectare), particle size analysis, and contaminant analysis for dustfall at regular intervals up to 100 m from the edge of clearing from the Project	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance

Valued Component	Follow-up and Monitoring Measure	Timing (Phase)	Timing (Years)
Riparian Habitat	Extent of the VC area overlapping with Project footprint activities, including the extent of rare and sensitive ecosystems	Construction and Pre-Production and Operations phases	Prior to disturbance only
	Extent of the VC area overlapping with occurrences of weeds and invasive, non-native species, as well as the area of implemented control/treatment measures	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Extent of the VC area overlapping with spills or releases of deleterious substances including sediment-laden water	Only required where overlapping with reportable spills or releases.	As applicable
	Plant species composition as well as the rate of deposition (i.e., mass/year/hectare), particle size analysis, and contaminant analysis for dustfall at regular intervals up to 100 m from the edge of clearing from the Project	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Species composition (quantified annually), water quality (monthly), and surface water/groundwater elevation in representative riparian habitats located immediately downstream of the Project in West Alexander Creek, at the confluence of West Alexander Creek and Alexander Creek, as well as the confluence of Alexander Creek with Michel Creek	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
Old Growth and Mature Forest	Extent of the VC area overlapping with Project footprint activities, including the extent of rare and sensitive ecosystems	Construction and Pre-Production and Operations phases	Prior to disturbance only
	Extent of the VC area overlapping with occurrences of weeds and invasive, non-native species, as well as the area of implemented control/treatment measures	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Extent of the VC area overlapping with spills or releases of deleterious substances including sediment-laden water	Only required where overlapping with reportable spills or releases	As applicable
	Plant species composition as well as the rate of deposition (i.e., mass/year/hectare), particle size analysis, and contaminant analysis for dustfall at regular intervals up to 100 m from the edge of clearing from the Project	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance

Valued Component	Follow-up and Monitoring Measure	Timing (Phase)	Timing (Years)
Wetlands	Extent of the VC area overlapping with, and adjacent to, Project footprint activities, including the extent of rare and sensitive ecosystems	Construction and Pre-Production and Operations phases	Prior to disturbance only
	Extent of the VC area overlapping with occurrences of weeds and invasive, non-native species, as well as the area of implemented control/treatment measures	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Extent of the VC area overlapping with spills or releases of deleterious substances including sediment-laden water	Only required where overlapping with reportable spills or releases	As applicable
	Plant species composition as well as the rate of deposition (i.e., mass/year/hectare), particle size analysis, and contaminant analysis for dustfall at regular intervals up to 100 m from the edge of clearing from the Project	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance
	Evaluation of wetland ecosystem function of wetlands adjacent to the Project footprint.	Construction and Pre-Production and Operations phases	Prior to disturbance, and Years 1, 3, and 5 following initial disturbance

13.9 Summary and Conclusions

Landscapes and ecosystems VCs assessed in this chapter included avalanche chutes, grassland ecosystems, riparian habitats, old growth and mature forests, and wetland ecosystems. The Project is predicted to have the potential to change the abundance and distribution of these VCs through overlap with the planned Project footprint. Additionally, effects were predicted to occur through:

- Alteration of disturbance regimes (in the case of avalanche chutes);
- Altered hydrological regimes (in the case of riparian habitat); and
- Potential effects to plant vigour (and therefore composition and structure) in all VCs associated with to the potential introduction and/or spread of weeds and invasive plant species and deposition of sediments and dust.

The effect of the introduction and/or spread of weeds and invasive species, as well as the deposition of sediments and dust, are able to be mitigated through standard industry practices. The Project's Ecological Restoration Plan (Chapter 33, Section 33.4.1.3) will assist in reducing the net effect of ecosystems impacted as a result of the Project; however, not all ecosystem VCs can be restored to baseline conditions.

For those potential effects that could not be completely mitigated and for which residual Project effects remained after mitigation, their potential to interact with the effects of other past, present, or reasonably foreseeable future projects or activities to result in cumulative effects was considered. The cumulative effects assessment assumed that the extent of effects to landscapes and ecosystem VCs from past and present projects or activities were largely encompassed in the existing (baseline) conditions for disturbed land cover/ecosystem types. Reasonably foreseeable future projects and activities were mapped for their incremental contribution to the overlap with landscapes and ecosystems VCs in the Landscapes and Ecosystems RSA. Assuming that the entire mapped area of a VC will be removed or substantially altered within the respective footprints of other projects or activities, changes in the abundance and distribution of applicable VCs were predicted throughout the Landscapes and Ecosystems RSA. Reasonably foreseeable future projects and activities were assumed to be held to the same regulatory requirements as the Project, and therefore are likely to involve the implementation of similar mitigation measures. Residual cumulative effects were predicted for all landscapes and ecosystems VCs; however, there were none considered to be significant, particularly in consideration of the Project's respective modest contribution to those cumulative effects.

Given that there was some uncertainty in several of the mitigation measures, as well as uncertainty in some of the preliminary data used to predict potential effects and the measures to mitigate them, confidence in the effects predictions was generally considered to be moderate, and therefore follow-up programs are recommended. Follow-up programs will allow for the Project to adaptively manage environmental effects as they arise throughout the phases of the Project.

13.10 References

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