# Addendum B

## Summary of Biophysical Factors that Support Ecosystem Function

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

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# B. Summary of Biophysical Factors that Support Ecosystem Function

## B.1 Introduction

Ecosystems within the Elk Valley provide habitat for fish, wildlife, and vegetation, 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). The function of an ecosystem depends on the differing physical, chemical, and biological components that make up an ecosystem, such as water, soil, vegetation, biota, and how these components interact with each other and across ecosystems (Environmental Assessment Office [EAO], 2020). Within the landscape, certain habitats and ecosystem services can disproportionately contribute to ecosystem functioning (United States Environmental Protection Agency [U.S. EPA], 1999). As such, an understanding of the potential effects to biophysical factors that support ecosystem function is important for consideration in project design, engineering and operations planning, as well as assessment and mitigation of potential environmental effects.

The purpose of this summary is to describe how biophysical factors that support ecosystem function may be affected by the Crown Mountain Coking Coal Project (the Project). In particular, this summary provides an overview of the current ecosystem function in the vicinity of the Project at landscape and watershed levels and identifies key biophysical factors that may interact with the Project. As well, this summary identifies the potential positive and negative effects of the Project interactions with biophysical factors and provides an overview of the predicted changes to ecosystem function as a result of the Project.
Key biophysical factors that support ecosystem function at landscape and watershed levels include (EAO, 2020):

- Habitats Supporting Ecosystem Function;
- Habitat Patches;
- Natural Disturbance Regime;

- Structural Complexity;
- Hydrologic Patterns;
- Nutrient Cycling;
- Purification Services;
- Biotic Interactions;
- Population Dynamics; and
- Genetic Diversity.

Biophysical factors that support ecosystem function have linkages with Project Valued Components (VCs) assessed as part of the Project Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS). In this summary, the Project VCs and related effects assessments are used to evaluate potential changes in biophysical factors that support ecosystem function. VCs that may interact with biophysical factors were primarily assessed in the following chapters of the Application/EIS:

- 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 13: Landscapes and Ecosystems Assessment;
- Chapter 14: Vegetation Assessment;
- Chapter 15: Wildlife and Wildlife Habitat Assessment; and
- Chapter 22: Human and Ecological Health Assessment.

# B.2 Regulatory and Policy Setting

Applicable provincial legislation and provincial and international guidance documents related to the assessment of biophysical factors that support ecosystem function are summarized in Table B.2-1. Legislation and guidelines relevant to each VC considered as part of this assessment are summarized within the Regulatory and Policy Setting subsections in the list of chapters outlined in Section B.1.

Table B.2-1: Legislation and Guidelines Relevant to Assessing Biophysical Factors that Support Ecosystem Function

| Legislation | Year | Description |
|---|---|---|
| Provincial | | |
| *Environmental Assessment Act* | 2018 | Provides a framework for the process of reviewing major projects and assessing their potential environmental impacts. Section 25(2)(e) of the Act requires that every assessment consider effects on biophysical factors that support ecosystem function. |
| Effects Assessment Policy | 2020 | Provides guidance to help environmental assessment participants and the public better understand British Columbia's environmental assessment process. |

| Legislation | Year | Description |
|---|---|---|
| Federal | | |
| DRAFT Offsetting Policy for Biodiversity | 2020 | Describes Environment and Climate Change Canada's (ECCC) approach to the application, design, and implementation of offsets for biodiversity for managing residual adverse effects arising from project developments. |
| International | | |
| Considering Ecological Processes in Environmental Assessments | 1999 | Provides guidance on how to incorporate ecological considerations into the preparation and review of environmental impact assessments (U.S. EPA, 1999). |

## B.3 Assessment Boundaries

The assessment boundaries used to evaluate the potential Project-related and cumulative changes to biophysical factors that support ecosystem function are the same as those spatial, temporal, administrative, and technical boundaries used in the assessment of relevant VCs in Chapters 6, 8 to 15, and 22 of this Application/EIS, and include:

- Atmospheric LSA and RSA;
- Air Quality LSA and RSA;
- Terrestrial LSA and RSA;
- Soil Quantity and Quality LSA;
- Groundwater LSA and RSA;
- Aquatic LSA and RSA;
- Fish and Fish Habitat LSA;
- Landscapes and Ecosystems LSA and RSA;
- Grizzly Bear RSA;
- Birds, Bats, and Amphibians RSA; and
- Human Health and Ecological Risk Assessment LSA and RSA.

## B.4 Overview of Current Ecosystem Function

The landscape surrounding the Project is characterized by old growth and mature forest, riparian habitat, avalanche chutes, and some grasslands and wetlands. The area is predominantly forested with lodgepole pine, Engelmann spruce, alpine fir, and limber and jack pine. The Elk Valley has abundant and diverse vegetation, although human land-uses are prevalent on the landscape and many habitats have been modified (EV-CEMF Working Group, 2018). Historical and current mining, forestry, and agricultural activities in the Elk Valley have resulted in removal, fragmentation, and modification of terrestrial ecosystems. Vegetation in the Elk Valley has also been impacted or lost through the development of local municipalities, off-road vehicle use, intensive grazing (both by wildlife and livestock), loss of natural fire patterns, introduction of invasive plant species, natural and anthropogenic air emissions, and climate change.

Key watercourses in the area of the Project include the Elk River, Michel Creek, Alexander Creek, West Alexander Creek, Harmer Creek, Michel Creek, and Grave Creek. Waterbodies in the immediate vicinity of the Project include Grave Lake and Harriet Lake. Historical and current mining activities in the Elk Valley have resulted in elevated concentrations of selenium, nitrate, sulphate, and cadmium in local watercourses, as well as calcite formation in some watercourses (Teck Resources Limited, 2014). Large-scale coal mining has occurred in the Elk Valley since the 1960s, which resulted in logging to support coal mining settlements (Swain, 2007), and is still ongoing in the region.

Agriculture and ranching are also common land uses in the region. The mountainous landscape of the region also provides an ideal location for both winter and summer recreation and tourism, with activities including hunting, fishing, hiking and mountain biking. Motorized recreation (i.e., ATV and snowmobile) activities also occur throughout the area. Recreational developments like Fernie Alpine Resort helped establish the Elk Valley region as an adventure destination, growing in popularity over time. Heli-skiing, cat-skiing and snowmobiling in B.C.'s southern Rockies gained popularity in the 1960s and 1970s (Kootenay Rockies, 2021; British Columbia Snowmobile Federation, 2021).

The Elk Valley region is an important part of the traditional territories of local Indigenous groups. It is acknowledged that the ceremonial, traditional and spiritual practices of local Indigenous communities are tied to the environmental and ecological attributes of their lands which have provided sustenance since time immemorial. As identified by the IAAC (IAAC, 2015a; IAAC, 2015b; IAAC, 2015c; IAAC, 2015d; IAAC, 2020a; IAAC, 2020b), the Project falls within the asserted traditional territories of the members nations of the Ktunaxa Nation (?akisq'nuk, yaqan nuykiy, ?aq'am, and Tobacco Plains Band), Shuswap Band, the Kainai, Piikani Nation, and Siksika Nation.

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 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. Impacts are assessed using five region-specific VCs selected by the EV-CEMF Working Group and include Westslope Cutthroat Trout, grizzly bear, bighorn sheep, old growth and mature forest, and riparian habitat. The EV-CEMF was used as an additional tool in the cumulative effects assessment for the Project Application/EIS for the region-specific VCs. Cumulative effects predictor models developed by the EV-CEMF were used and the results of the EV-CEMF modeling are presented and discussed for each region-specific VCs, specifically Westslope Cutthroat Trout, grizzly bear, bighorn sheep, old growth and mature forest, and riparian habitat in the respective Application/EIS chapters.

The sections below provide a summary of the biophysical factors that support ecosystem function and relevant information on biophysical Project VCs to understand the current ecosystem functions within and surrounding the Project.

### B.4.1 Habitats Supporting Ecosystem Function

Habitats supporting ecosystem function constitute unique or critical habitats at the regional or landscape level that support key ecosystem functions and processes such as hydrologic patterns, nutrient cycling, and structural complexity (EAO, 2020; U.S. EPA, 1999). These habitats often support higher levels of biodiversity compared to the surrounding landscapes. Five ecosystem VCs that provide unique features on the landscape and comprise important habitat components within and/or surrounding the Project include (AIR; EAO, 2018):

- Avalanche chutes;
- Grasslands;
- Riparian habitat;
- Old growth and mature forest; and
- Wetland ecosystems.

#### B.4.1.1 Avalanche Chutes

Avalanche chutes are features that are common to mountain ecosystems maintained by frequent snow, rock, and ice avalanches (Quinn and Phillips, 2000) and provide important foraging habitat for wildlife during the spring and summer months (e.g., bighorn sheep [*Ovis canadensis*], mountain goat [*Oreamnos americanus*], and grizzly bear [*Ursus arctos horribilis*]). 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).

Avalanche chutes comprise 603 ha or 5% of the Landscapes and Ecosystems LSA and occupy an area of approximately 12,347 ha, or less than 4% of the Landscapes and Ecosystems RSA. The Project and other cumulatively interacting activities would remove a proportionally similar extents of avalanche chute habitat in the Landscapes and Ecosystems LSA (i.e., 5%) and RSA (i.e., 4%), respectively. Further, although the predicted effects of climate change influencing precipitation cannot be accurately predicted for the purposes of this assessment, the extent of change is anticipated to be generally consistent throughout the extent of the Landscapes and Ecosystems RSA.

#### B.4.1.2 Grassland Ecosystems

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). The Red-listed Gg12 rough fescue - (bluebunch wheatgrass) - yarrow - clad lichens association, located with the LSA and RSA, (Festuca campestris - (*Pseudoroegneria spicata*) - Achillea borealis – Cladonia spp.) is known to have been impacted by ungulate overgrazing (MacKillop et al., 2018) and may be permanently modified in some areas (B.C. CDC., n.d.b; Suding and Hobbs, 2009). Sites in good condition are highly limited and subject to grazing pressure by ungulates and domestic livestock (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. These ecosystems contribute to overall ungulate species survival with grasslands providing rich sources of food (Poole and Mowat, 2005; Hebblewhite and Merrill, 2009), and low resistance movement corridors facilitating access to forested shelter, water, and calving sites (Poole and Stuart-Smith, 2006; Gorley, 2016). Additionally, carnivores such as the American badger have an important functional role in grassland ecology, influencing a wide range of soil functions that benefit grassland vegetation when they excavate and occupy their burrows (Eldridge, 2004; 2009; Eldridge and Whitford, 2008). Grasslands are also important for keystone species such as grizzly bear which consume a wide variety of plant material (e.g., berries, forbs, roots, and graminoids) (Hamer and Herrero, 1987a; McLellan and Hovey, 1995; Gyug et al., 2004) and use these grassland areas to prey on ungulate species commonly found in this habitat (Cristescu et al., 2011).

Grassland ecosystems comprise approximately 1.55% (200 ha) of the Landscapes and Ecosystems LSA and 0.97% (13 ha) of the Project footprint. Grassland ecosystems occupy an area of approximately 6,812 ha, or 2% of the total area of the Landscapes and Ecosystems RSA. Although cumulative loss of grassland habitat in the Landscapes and Ecosystems RSA is predicted to exceed 15%, the Project's contribution would be negligible (i.e., 0.08%) and disproportionately low relative to other activities in the Landscapes and Ecosystems RSA.

#### B.4.1.3 Riparian Habitats

Riparian habitat represents the transition zone between the aquatic environment (e.g., rivers, streams, lakes, and wetlands) and upland ecosystems and provide important habitat for a variety of terrestrial and aquatic species (Province of B.C., 1995). The EV-CEMF (Davidson et al., 2018) has identified riparian habitat as a VC (Province of B.C., 2020) because these ecosystems have high biodiversity and provide critical habitats, home ranges, and travel corridors for wildlife, acting as key linkages between low and high elevation terrain, and forested and non-forested areas throughout the landscape. In addition, high-quality western cutthroat trout habitat is largely controlled by riparian areas (Davidson et al., 2018).

Riparian ecosystems comprise approximately 9% (1,138 ha) of the Landscapes and Ecosystems LSA and to 6% of the Project footprint, or up to 7% of the riparian habitat within the Landscapes and Ecosystems LSA. Riparian habitats occupy an area of approximately 26,697 ha, or approximately 8% of the Landscapes and Ecosystems RSA.

#### B.4.1.4 Old Growth and Mature Forest

The amount of old growth first 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 growth and mature forests occur across 919 ha of the Project footprint. Forest abundance and distribution throughout the Landscapes and Ecosystems RSA and LSA have been influenced by a history of wildfire, wildfire suppression, disease, logging, mining, and European settlement (Holmes et al., 2018). Additionally, old growth forest in the Elk Valley includes species such as whitebark pine, which is federally listed as Endangered under Schedule 1 of the federal Species at Risk Act, and Blue-listed provincially in B.C. Whitebark pine is noted as occurring in the Landscapes and Ecosystems LSA and Landscapes and Ecosystems RSA at high elevations (Lea, 1984; MacKillop et al., 2018; Parish, 1948). Whitebark pine is considered to have scientific, ecological, social, and cultural and historical importance but is at risk due to its delayed age of maturity, lower dispersal rate, reliance on dispersal agents, and white pine blister rust, contributing to its high risk for extirpation in Canada (COSEWIC, 2010).

#### B.4.1.5 Wetland Ecosystems

Wetland ecosystems provide habitat for a variety of terrestrial and aquatic species, including migratory birds and several sensitive and/or listed species, such as western toad. Wetland habitats are also used by a variety of carnivore and ungulate species for foraging. Wetlands also maintain and improve water quality through their ability to filter pollutants and sediments. Wetland and flood ecosystems are abundant and extensive along the major river valleys of the East Kootenay, including the Columbia, Kootenay, and Elk Rivers (MacKillop et al., 2018). Beyond these valley bottom floodplains, wetlands are small and uncommon, but provide important landscape variability that influences biodiversity and stability.

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. Wetland ecosystems occupy approximately 1% of the Landscapes and Ecosystems RSA (i.e., 3,979 ha out of 350,919 ha).

### B.4.2 Habitat Patches

The size, number, quantity, and distribution of habitat patches across the landscape support the movement of species and the transfer of energy and nutrients among habitats (EAO, 2020). Prior to colonization, natural landscapes were characterized by large expanses of contiguous habitat (U.S. EPA, 1999). Fragmentation of habitat into disconnected and isolated patches can disrupt ecological integrity, with edge effects further reducing the ecological function of habitat patches (EAO, 2020; U.S. EPA, 1999). In the Elk Valley, habitat fragmentation has occurred due to settlement, mining, forestry, linear disturbance, wildfires and fire suppression, insect outbreaks, agriculture, and recreation and tourism. These activities have resulted in disconnected and isolated patches of habitats supporting ecosystem function, affecting the abundance and distribution of wildlife.

A variety of landscapes and ecosystems occur within and surrounding the Project, including forested areas, grasslands, alpine environments with avalanche chutes, and riparian areas. Across the Landscapes and Ecosystems RSA and LSA, the connectivity of grasslands is low, with high elevation grasslands found on isolated peaks in patches on warm aspect steep sites. Old growth forest, and to a lesser extent mature forest, in the Elk Valley is well below historic amounts due to forest harvesting, with current old growth and mature forests now being highly fragmented in small patches, especially at lower elevations (Holmes et al., 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). Both grasslands and old growth forest provide sheltered areas for foraging and raising young for wildlife VCs such as birds, bats, ungulates, and carnivores. Fragmentation of habitat can affect wildlife by changing movement pathways from previously connected habitats (e.g., connection of old growth to riparian areas is important for ungulate and carnivore movement), limiting food sources (e.g., food sources can become segmented requiring more caloric expenditure to reach them), and increased human-wildlife interaction as wildlife cross disturbed areas to reach suitable habitats.

Along watercourses surrounding the Project, riparian habitat provides important wildlife corridors in the Terrestrial LSA. Ungulates use riparian areas for low resistance movement from forage areas (high alpine avalanche chutes) to calving sites in grassland areas (Bowyer et al., 2003; Poole and Stuart-Smith, 2006). Connectivity of riparian areas in the Elk Valley is important for linear movements of many carnivore and ungulate species, including multiple wildlife VCs. Riparian habitats also contribute to the success and wellbeing of fish VCs as mature riparian habitats can provide instream cover and habitat diversity, transfer of nutrients, and increased food sources from both vegetation and invertebrates present in these areas (Covich et al, 1999; Van de Bund et al., 1994; Wallace and Webster, 1996).

In general, wetlands in the East Kootenay have experienced loss and degradation due, in part, to alteration of habitat connectivity from historic and current intensive land development for agriculture, forestry, mining, water, and recreational use (Fish and Wildlife Compensation Program (FWCP) and Columbia Basin Trust (CBT), 2014). Connectivity limits the quality and abundance of wetlands. 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. The wetland habitats within the project area lack connectivity due to previous loss and habitat degradation through land development activities (Fish and Wildlife Compensation Program (FWCP) and Columbia Basin Trust (CBT) 2014). Wetland patches, even if small in area, can provide habitat for plants with high habitat specificity and in turn provide for species such as the Olive-sided Flycatcher (Blue-listed and listed as Threatened on Schedule 1 of SARA).

### B.4.3 Natural Disturbance Regime

Natural disturbance events, such as wildfires, floods, insect outbreaks, and avalanches, can result in significant changes in ecosystem structure and/or composition. The natural disturbance regime of an ecosystem comprises the type, magnitude, and frequency of disturbances that could occur within the landscape in the absence of anthropogenic activities (EAO, 2020; U.S. EPA, 1999). Disruption of natural disturbance regimes can result from fire suppression, avalanche control, flood control, land clearing, and other anthropogenic activities. In the Elk Valley, natural disturbances have resulted in ecosystem and habitat changes affecting diversity in plant and animal communities and their interactions, further shaping the landscape surrounding the Project.

Natural disturbance has also contributed to changes in the hydrology and geomorphology of watercourses in the Elk River watershed. The most recent extreme flooding events in the region occurred in 1974, 1995, and 2013 and were caused by large precipitation events at near-peak snowmelt (Pomeroy et al., 2016). Extreme floods have the potential to alter the width and depth of channels by erosion. 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).

Forest abundance and distribution throughout the Elk Valley have been influenced by a history of both wildfires and wildfire suppression (Holmes et al., 2018). 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 natural disturbances include fire and insect outbreak (Holmes et al., 2018). Fire and mountain pine beetle have and continue to influence landscape-level structure and tree species composition in the Elk Valley, which influences wetlands in the forest matrix. 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. 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). 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, 2010; Poole and Ayotte, 2019). As a result, trees and shrubs have encroached into grasslands, shifting vegetation from grasslands to forested communities. Fire suppression practices have resulted in a greater abundance of young forests, reducing the abundance of unforested structural stages (Kirby and Campbell, 1999).

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). 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). In the Elk Valley, active avalanche control measures are applied in access corridors where they transect major avalanche features.

### B.4.4 Structural Complexity

Structural complexity refers to physical features at a local scale that provide for a greater diversity of ecological niches and more complex interactions among species (U.S. EPA, 1999; EAO, 2020). The structural complexity of an ecosystem can be altered through natural and anthropogenic disturbances. Examples of features that increase structural complexity include snags in a forest or large woody/ beaver dams and debris in watercourses, as well as microhabitats between riparian zones and wetlands created by seasonally changing water levels. In the Elk Valley and surrounding the Project, a wide variety of ecosystems exist from high alpine mountains and avalanche chutes, to wetlands and riparian areas providing important habitat to keystone species such as grizzly bear. The ecological niches provided by structural complexity in the Elk Valley contribute to positive species interactions and continue to bolster biodiversity throughout the region.

Stream complexity, including meander patterns, riffle-pool sequences, and woody debris, are important features to maintaining instream cover and subsequently rearing habitat of Threatened species such as Westslope Cutthroat Trout (COSEWIC, 2016), who rely on deep pools for overwintering and gravels and debris for spawning and survival (Scott and Crossman 1973; Nelson and Paetz 1992). Westslope Cutthroat Trout are found in West Alexander Creek, a watercourse which provides aquatic structural complexity for invertebrates and fish by providing cover through small and large woody debris and boulders throughout reaches of the stream. This creek also contains elements such as cobble and small gravel which can provide spawning habitat.

Riparian areas provide structural complexity over cycles of vegetative growth and natural disturbance, providing nutrient input to watercourses and waterbodies. Riparian areas also contribute to the structural complexity of fish and fish habitat by providing overhead cover, shading, and instream cover. These areas often include a variety of substrates (e.g. cobble, clay, sediment, bedrock) and have woody debris present that has been carried downstream during flood events. Structural complexity in wetlands is an important factor in determining wetland function and habitat quality for a variety of flora and fauna.

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; RISC, 1999a) including VCs such as Pileated Woodpecker (*Dryocopus pileatus*; Carey et al., 1991; Harestad and Keisker, 1989) and American marten (*Martes americana*; Bonar, 2000).

### B.4.5 Hydrologic Patterns

Hydrologic patterns refer to the movements of freshwater and groundwater through ecosystems, providing water for species and physical structure for habitats (EAO, 2020; U.S. EPA, 1999). Movement of water throughout ecosystems is crucial for the transport of both abiotic (e.g., sediments) and biotic (e.g., plants and invertebrates) materials. Natural hydrologic patterns include the magnitude, frequency, duration, timing, and flashiness of water flows (U.S. EPA, 1999). Waterbodies such as ponds, lakes and wetlands retain water and can help moderate flooding.

The Elk Valley is situated over the dividing line of Upper Kootenay Basin and the Central Kootenay Basin hydrologic zones. The Elk River watershed covers an area of approximately 4,381 $km^2$ and is generally oriented in a north to south direction. Hydrology within and surrounding the Project is influenced by natural factors (e.g., climate; relief; geology; vegetation) and anthropogenic factors (e.g., mining; forestry; climate change). Key watercourses in the area of the Project include the Elk River, Michel Creek, Alexander Creek, West Alexander Creek, Harmer Creek, Michel Creek, and Grave Creek with waterbodies including Grave Lake, Harriet Lake, Mite Lake, and Barren Lake.

Alexander Creek, West Alexander Creek, and Grave Creek represent key watercourses in closest proximity to the Project. Development of the mine site will result in the removal of approximately 5.5 km of West Alexander Creek. The Alexander Creek watershed is the largest drainage basin near the Project and covers a watershed area of approximately 18,490 ha, which is oriented in a north to south direction. Alexander Creek flows in a southerly direction from its headwaters to its confluence with Michel Creek, approximately 10.7 km southeast of Sparwood. Alexander Creek has numerous tributaries that generally consist of high-gradient mountain streams, with the most significant tributary being West Alexander Creek The West Alexander Creek watershed covers an area of approximately 1,470 ha within the boundaries of the Alexander Creek watershed. West Alexander Creek flows in a south to southeast direction over a distance of approximately 6 km to its confluence with Alexander Creek. The watercourse has several tributaries that generally consist of small, high-gradient mountain streams. The Grave Creek watershed covers an area of approximately 8,090 ha and is oriented in an east to west direction. Grave Creek generally flows westerly and drains into the Elk River, approximately 12.5 km north of Sparwood. Several tributaries drain into Grave Creek, the largest of which being Harmer Creek. Wetland catchments within and near the Project are drainage subunits of, and occur within, the greater drainage areas identified as the Alexander Creek, Elk River, Grave Creek, and Harmer Creek watersheds. Wetland catchment areas range in size across the Terrestrial LSA and occur across small, lower elevation areas to larger areas at mid-elevation.

### B.4.6 Nutrient Cycling

Nutrient cycling refers to nutrient flows into and out of an ecosystem. Nutrient cycling, in combination with sunlight and water, determines the productivity of an ecosystem (U.S. EPA, 1999). Reduction or addition of nutrients to ecosystems can alter natural trophic structure and resiliency, affecting the quality of the natural environment (U.S. EPA, 1999). Key nutrients that contribute to ecosystem productivity include dissolved inorganic and dissolved organic particulate nitrogen (N) and phosphorus (P), as well as oxygen in aquatic environments (U.S. EPA, 2023). These nutrients cycle in an ecosystem through land cover alterations and aquatic channel alterations which can funnel nitrogen and phosphorus into streams and receiving terrestrial areas which further contributes N and P to plant assemblage structures which are food resources and habitat structures for wildlife VCs contributing to nutrient flow through trophic levels. In aquatic environments, these nutrients are required for the growth of macrophytes, periphyton, and phytoplankton which contribute to dissolved oxygen levels in rivers and streams providing the necessary life sustaining conditions for fish species such as Westslope Cutthroat Trout.

Nutrients, metals, and other particles flow into and out of the regional and local areas surrounding the Project through surface water and groundwater. Within and surrounding the Project, watercourses carry metals such as cadmium, copper, iron, selenium and nutrients such as N, P, and oxygen downstream to subsequent watersheds where these metals and nutrients continue cycling or building up throughout the ecosystem (e.g., bioaccumulating in tissues of fish). Concentrations of the metals and nutrients can change seasonally with higher concentrations moving downstream in spring freshet and throughout the growing season, and more slowly during frozen conditions in the winter. Metals are largely leached from surface to groundwater through areas of high porosity in the subsurface such as wetland areas that may be spring fed, furthering an exchange of nutrients and metals. Historical and current mining activities in the Elk Valley have resulted in elevated concentrations of selenium, nitrate, sulphate, and cadmium in local watercourses (Teck, 2014). Sources of nitrogen and phosphorus input into waterways include local municipalities, agriculture, forestry, deposition from natural and anthropogenic air emissions, as well as allochthonous materials.

Different habitat types contribute to nutrient cycling through different processes. Grassland habitats store nutrients such as carbon in their stalks, leaves and roots, and uptake phosphorus and nitrogen from the soil. N and P are typically slowly released over time as ammonia in the atmosphere or nitrate through runoff from precipitation (Mason, J.A., Zanner, C.W. 2005). 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. Old growth forest ecosystems store nutrients (i.e. atmospheric carbon dioxide [$CO_2$]) through sequestration, producing oxygen and fixing nitrogen from its elemental form to compounds such as ammonia or nitrous oxide (Luyssaert et al., 2008). The function of carbon storage by old growth forests contributes to the stability of atmospheric $CO_2$ levels, as well as to the fixation of nitrogen and phosphorus through root systems and leaf litter. 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).

Riparian habitats are often biologically diverse and contribute to nutrient cycling through the uptake of excess nutrients, as well as the input of nutrients to waterbodies by forming the base of food webs and deposition of nutrients into waterbodies through leaf litter. Riparian areas are common along the Elk River and otherwise occur in relatively narrow bands in other areas of higher relief due to steep banks or very coarse streambank soils (Keefer Ecological Services, 2020). Wetlands cycle nutrients through abiotic and biotic processes, such as the 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, and production of soils. Wetland and flood ecosystems occur along Alexander Creek and the Elk River. Beyond these valley bottom floodplains, wetlands are generally small and uncommon.

## B.4.7 Purification Services

Purification services are the physical, chemical, and biological mechanisms of removing, sequestering, assimilating, and changing chemicals in the air, water, and soil (EAO, 2020; U.S. EPA, 1999). Purification processes are necessary for the functioning of ecosystems by detoxifying harmful materials and re-fertilizing soils and sediments through the actions of microbes and other organisms (U.S. EPA, 1999). Within and surrounding the Project, purification services are largely provided by forests, wetlands, and watercourses. Purification services impact the cycling of nutrients, the total ecosystem load of metals and nutrients from both natural and anthropogenic sources contributing to overall ecosystem health and support of fish, wildlife, and other associated Project VCs.

Forests, wetlands, and watercourses function to purify adjacent habitats through processes such as filtration or increasing retention time, allowing for settlement. Wetlands contribute to ecosystem purification through abiotic and biotic processes, such as the 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, and production of soils. Wetland and flood ecosystems occur along Alexander Creek, south of the Project. Less than 1 ha of wetlands occur within the Project footprint; however these areas provide ecosystem services such as maintaining and improving water quality through their ability to filter pollutants and sediments. Riparian habitats contribute to ecosystem purification through the filtration of excess nutrients and pollutants from water run-off. Riparian vegetation also stabilizes banks, slowing the rate of run-off, reducing sedimentation and pollution of watercourses. Old growth forest and grassland ecosystems contribute to purification services through sequestration of excess nutrients and pollutants (e.g., carbon). Old growth forests specifically sequester and store atmospheric $CO_2$ while grasslands can sequester carbon in vegetation cover such as biological soil crusts. Biological soil crust can reduce the risk of soil erosion from wind and water, increase the carbon and nitrogen contributions to soil, and increase soil water infiltration (Rosentreter et al., 2007).

## B.4.8 Biotic Interactions

Biotic interactions refer to the symbiotic or antagonistic interactions among organisms, including predation, competition for resources, mutualism, and parasitism (EAO, 2020; U.S. EPA, 1999). The removal or addition of species to an ecosystem can dramatically alter the composition, structure, and function of an ecosystem. The interactions of keystone or foundation species are particularly important in maintaining ecosystem structure and function (U.S. EPA, 1999). Species of importance which influence interactions within and surrounding the Project include top predators such as grizzly bear and Canada lynx. Ungulate species impact ecosystem health through herbivory and providing prey for carnivores, as well as the impact of bird and bat communities on insect population and vegetation seed distribution.

Carnivores are important for ecosystem health and function, regulating prey population numbers and distribution through carnivory (Ripple et al., 2014). Due to their large space requirements and naturally low population densities and reproductive rates, carnivores are sensitive to landscape change resulting in habitat loss (including loss of prey), habitat fragmentation (i.e., loss of connectivity), and mortality (Carroll et al., 2001; Ripple et al., 2014). Given that carnivores' distributional patterns can be strong indicators of functioning ecosystems and regional-scale population processes, their conservation management is a priority in the Rocky Mountain region (Carroll et al., 2001). According to the Grizzly Bear RSA (South

Rockies Grizzly Bear Population Unit [GBPU]) there are an estimated 239 grizzly bears, corresponding to a population density of approximately 2.9 individuals/ 100 $km^2$ (Lamb et al., 2020).

Biotic interactions can influence resource selection within predator-prey relationships, as is the case for the Canada lynx and the snowshoe hare. A model was developed for the relationship between these species and the results showed that Canada lynx selected for habitats with a greater than 60% probability of being selected by snowshoe hare (Teck Coal Limited, 2014). Both species were found to select for habitats characterized by mid-elevation coniferous forests, gentle slopes, and cool aspects (Teck Coal Limited, 2014). Further, change in vegetation structure or forest cover from logging can impact the value of habitat for certain species, forcing predators such as Canada lynx elsewhere, altering biotic interactions in those areas. Although there is limited data on Canada lynx population trends in the Terrestrial RSA, a minimum population density from hair snagging found 0.74 Canada lynx per 100 $km^2$ in the Elk Valley (Apps et al., 2007).

Ungulates can influence vegetation structure, composition, succession, and diversity by grazing and/or browsing, dispersing nutrients, and compacting soils (Kjell et al., 2006; Smit and Putman, 2010; Vavra and Riggs, 2010). Birds and bats also contribute to biotic processes such as seed dispersal in addition to ungulates; however, no bat roosts were identified during baseline surveys within or directly adjacent to the project footprint. Migratory birds are ecologically and economically valuable as they: help regulate pest insect and rodent populations affecting agriculture and forestry; act as pollinators in both seed dispersion and flower pollination; contribute to socio-economic activities (i.e., hunting and birdwatching); and contribute to the overall health and biodiversity of aquatic and terrestrial ecosystems (United Nations Environment Programme, 2012).

## B.4.9 Population Dynamics

Populations and subpopulations are the units used to measure species success in a region (EAO, 2020); however, population numbers alone do not adequately reflect the ability for a species to sustain itself or its ecological role (U.S. EPA, 1999). Understanding a species life history and population dynamics, such as dispersion, fertility, recruitment, and mortality rates, is necessary to identify potential effects on population survival and ecological processes. In the Elk Valley, populations are influenced by many factors, including both natural- and human-influenced processes. Natural processes influencing population dynamics include competition for resources between different species (e.g., moose, elk, mule deer), natural disturbance regimes (e.g., fire, flood, avalanche) reducing habitat or directly affecting population numbers through mortality. Anthropogenic influences in the vicinity of the Project include the development of linear corridors, such as highways, which can decrease suitable habitat for life processes of species such as mating and rearing of young, as well as directly contribute to population decreases through human-animal interactions (e.g. motor vehicle accidents, hunting pressure).

Roads increase both ungulate (e.g. moose, elk, mule deer) and large carnivore (e.g. grizzly) mortality risk directly via collisions with vehicles, and indirectly by increasing hunter access and facilitating predator movement (i.e., enhancing predation rates; GOABC, 2016; RISC, 1999b). Further, an increase in the extent of linear access features (e.g., roads and off-road tracks) can result in reduced habitat values (e.g., security cover and access to forage) and a reduced population density for ungulates (RISC, 1999b; Rea, 2003; Fahrig and Ryntwinski, 2009; Harris et al., 2014; FLNRO, 2015; GOABC, 2016; Gorley, 2016). Highway 3 has been shown to fragment grizzly habitat making it so that they have to cross major roadways for access to forage habitat, causing more interactions with vehicles negatively affecting population.

In the Elk Valley, federally endangered whitebark pine stands that have high infection rates of white pine blister rust have been found to be at higher risk of seed predation, further reducing the ability of populations to regenerate through decreased recruitment. Whitebark pine is predicted to occur in up to 1,375 ha and 591 ha in the Landscapes and Ecosystems LSA and Project footprint, respectively. An average infection rate of whitebark pine with whitebark pine blister rust was found to be 69% in reproductive whitebark pine, with the infection increasing as tree size increased. Unless resistant to white pine blister rust, any limber pine individuals that may incidentally occur in the Landscapes and Ecosystems LSA are likely to be infected due to the high rates of infection in the whitebark pine population. The example of whitebark pine with natural infection in combination with anthropogenic impacts such as habitat removal can contribute to increased threat or extinction of protected species.

### B.4.10 Genetic Diversity

Genetic diversity enables a population to respond to natural selection by helping it to react and adapt to external pressures (EAO, 2020). Maintaining genetic diversity is essential to allow populations to adapt to future stressors (U.S. EPA, 1999). In the Elk Valley, anthropogenic activities have resulted in changes in gene flow and genetic diversity for Westslope Cutthroat Trout, carnivore species (e.g., grizzly bear, wolverine, and American marten), and whitebark pine. Transportation corridors and the building of urban centers has resulted population fragmentation in both ungulates and carnivore species by providing barriers of movement and areas of high collision risk which ultimately can lead to loss of gene flow (Clevenger et al., 2010; Lamb et al., 2018; and Lee et al., 2019).

As stated previously in Section B.4.2, low resistance movement corridors connect important habitat patches that are used seasonally and facilitate access to important resources including mineral licks and calving sites for ungulates (Poole and Stuart-Smith, 2006; Gorley, 2016), and to the location of prey and resting sites for carnivores such as grizzly bears. These movement corridors also contribute to the fecundity and success of species contributing to genetic diversity throughout the region. Currently within the Elk Valley, the associated effects of the Highway 3 corridor have resulted in a loss of gene flow between grizzly bear and wolverine populations due to direct mortality and the disconnection of previously connected habitat (Apps et al., 2007; Proctor et al., 2012; 2015; Mowat et al., 2020b). In addition, major roads in the Elk Valley (e.g., Highway 3 and 43) may often form boundaries of Canada lynx home ranges resulting in habitat fragmentation and a loss of connectivity (Apps et al., 2007; Clevenger et al., 2010). Other human disturbances (e.g., mining, reclamation activities, urban development) create higher resistance landscapes and reduce population connectivity and gene flow (Apps, 2000; Teck Coal Limited, 2014). On the broader scale of genetic diversity within the Elk Valley, the fragmentation of habitat has had the largest impact on this biophysical factor.

## B.5 Biophysical Factors Assessment

The B.C. *Environmental Assessment Act* (2018) requires that an effects assessment be conducted to evaluate the potential direct and indirect effects of a Project on biophysical factors that support ecosystem function. The following section describes potential effects of the Project on relevant biophysical factors and provides an overview of the predicted changes to ecosystem function as a result of the Project.

## B.5.1 Assessment Methods

The assessment of potential impacts to biophysical factors that support ecosystem function included the following:

- Identification of how the Project interacts with biophysical factors (Section B.5.2; EAO, 2020);
- Assessment of the biophysical factors that support ecosystem function using relevant Project VCs to allow for the consideration of potential effects on landscapes, watersheds, and ecosystems (Sections B.5.2 and B.5.3); and
- Determine the potential effects on biophysical factors that support ecosystem function as well as any new mitigation measures relevant to address the identified effects (Sections B.5.3, B.5.4, and B.5.5); and
- Summarize predicted changes to ecosystem function as a result of the Project (Section B.5.6).

The assessment of potential effects on ecosystem function and the related biophysical factors is based on the predicted potential Project-related residual and cumulative effects identified for relevant VCs in the Application/EIS. As noted in Section B.3, the assessment of biophysical factors used relevant VC study areas of appropriate temporal and spatial scales that were relevant to both the potential Project effects and the identified biophysical factors. Positive effects resulting from the Project are associated with the economics VCs. No positive effects to the biophysical factors and VCs associated with the Project have been identified and are anticipated as a result of the Project.

## B.5.2 Biophysical Factors and Valued Components

Valued components (VCs) assessed as part of the Project Application/EIS contribute to ecosystem functioning across various landscapes and watersheds. Table B.5-1 summarizes the interactions between key biophysical factors that support ecosystem function and the Project VCs. Visual representation of the interactions between the Project VCs and the biophysical factors that support ecosystem function is provided in Figure B.5-1.

Table B.5-1: Summary of Interactions between Biophysical Factors and Project Valued Components

| Biophysical Factor | VCs Linked to Changes in Biophysical Factor | Summary of Interaction with Project |
|---|---|---|
| Habitats Supporting Ecosystem Function | • Avalanche Chutes<br>• Grassland Ecosystems<br>• Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems | The Project may affect habitat diversity and structural complexity through the removal and indirect changes of landscapes and ecosystems that provide habitat value. Changes to vegetation communities, such as avalanche chutes, grasslands, riparian areas, old growth forests, and wetlands may reduce habitat availability and suitability for wildlife, fish, and listed plants VCs. Potential effects of the Project on habitat supporting ecosystem function can be found in Section B.5.3.1. |
| Habitat Patches | • Avalanche Chutes<br>• Grassland Ecosystems | Existing habitat patches may be impacted through Project site development, in particular site preparation and construction |

| Biophysical Factor | VCs Linked to Changes in Biophysical Factor | Summary of Interaction with Project |
|---|---|---|
| | • Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems | activities, and result in the fragmentation of existing habitat and ecosystems and indirect adverse edge effects. Reduction of habitat patches across the landscape may reduce the abundance and distribution of wildlife. Potential effects of the Project on habitat patches can be found in Section B.5.3.2. |
| Natural Disturbance Regime | • Terrain<br>• Surface Water Quantity<br>• Avalanche Chutes<br>• Grassland Ecosystems<br>• Old Growth and Mature Forest | The occurrence of natural disturbance regimes, such as wildfire, flood, and avalanches, may be reduced as a result of Project development due to fire suppression activities within and surrounding the Project footprint, use of artificial avalanche triggers, and forest clearing. Reduction in natural disturbances on the landscape may impact natural cycles of ecosystem regeneration. Potential effects of the Project on natural disturbance regimes can be found in Section B.5.3.3. |
| Structural Complexity | • Terrain<br>• Avalanche Chutes<br>• Grassland Ecosystems<br>• Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems | The Project may result in a reduction of structural complexity across some landscapes and ecosystems due to the direct loss of local scale features that contribute to ecological niches and support complex interactions among species. The effects on structural complexity may have interactions with VCs such as fish and listed and sensitive plant communities due to the removal and change in riparian habitat along West Alexander Creek. Potential effects of the Project on structural complexity can be found in Section B.5.3.4. |
| Hydrologic Patterns | • Terrain<br>• Groundwater Quantity<br>• Surface Water Quantity | Changes to hydrologic patterns within and surrounding the Project have the potential to occur as a result of the alteration of surface water flow and groundwater baseflow. Streamflows may be affected by changes to hydrologic characteristics (e.g., land use, drainage pathways) in the Grave Creek and West Alexander/Alexander Creek watersheds over site construction as well as water withdrawals at Grave Creek for process water. Groundwater patterns have the potential to be impacted through reductions in groundwater baseflow at West Alexander Creek and Alexander Creek as a result of mine development. Potential effects of the Project on hydrologic patterns can be found in Section B.5.3.5. |
| Nutrient Cycling | • Surface Water Quality<br>• Grassland Ecosystems<br>• Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems | The Project has the potential to impact nutrient cycling by altering or removing terrestrial and aquatic ecosystems in the vicinity of the Project which store and cycle nutrients or by discharging contaminants to terrestrial and aquatic ecosystems. Changes to nutrient cycling can potentially affect trophic structure and resiliency by limiting growth due to nutrient deficiencies and changes in nutrient flow through ecosystems. Potential effects of the Project on nutrient cycling can be found in Section B.5.3.6. |
| Purification Services | • Air Quality<br>• Avalanche Chutes<br>• Grassland Ecosystems | Purification services may be altered through the direct loss and indirect changes of landscapes and ecosystems that are capable of sequestering chemical and physical constituents |

| Biophysical Factor | VCs Linked to Changes in Biophysical Factor | Summary of Interaction with Project |
|---|---|---|
| | • Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems<br>• Wildlife Health | from the surrounding environments. The Project may reduce the availability of terrestrial ecosystems, such as riparian habitats and wetlands, that provide filtration of surface water or sequestration of pollutants. Potential effects of the Project on purification services can be found in Section B.5.3.7. |
| Biotic Interactions | • Avalanche Chutes<br>• Grassland Ecosystems<br>• Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems<br>• Whitebark Pine<br>• Westslope Cutthroat Trout<br>• Benthic Invertebrates<br>• Ungulate Community<br>• Carnivore Community<br>• Bat Community<br>• Bird Community<br>• Amphibian Community | Direct and indirect changes to terrestrial and aquatic ecosystems and the habitat provided by these ecosystems may impact biotic interactions at a landscape and/or watershed level. Biotic interactions may be directly influenced through the loss of wildlife and aquatic habitat while indirect changes may result from increased use of access roads and higher wildlife mortality. Biotic interactions may also be influenced by the change in number of individuals in the ecosystem area, through yearly streamflow quantities, or change in natural disturbances due to Project activities. Potential effects of the Project on biotic interactions can be found in Section B.5.3.8. |
| Population Dynamics | • Grassland Ecosystems<br>• Riparian Habitat<br>• Old Growth and Mature Forest<br>• Wetland Ecosystems<br>• Whitebark Pine<br>• Westslope Cutthroat Trout<br>• Bull Trout<br>• Benthic Invertebrates<br>• Ungulate Community<br>• Carnivore Community<br>• Bat Community<br>• Bird Community<br>• Amphibian Community<br>• Wildlife Health<br>• Aquatic Health | Population dynamics may be influenced by the direct loss of aquatic and terrestrial ecosystems as a reduction in habitat availability may adversely affect life-history characteristics. Indirect effects to population dynamics may occur as a result of invasive plant species introductions and disruption of native plant populations. Removal of aquatic habitat has the potential to influence yearly spawning and rearing of fish populations and for fish species to carry out life processes. The alteration of forest and riparian habitat may alter population dynamics by affecting the amount of habitat available for breeding ungulate species individuals. Potential effects of the Project on population dynamics can be found in Section B.5.3.9. |
| Genetic Diversity | • Grassland Ecosystems<br>• Riparian Habitat<br>• Old Growth and Mature Forest<br>• Westslope Cutthroat Trout<br>• Ungulate Community<br>• Carnivore Community | Fragmentation of terrestrial and aquatic wildlife habitat due to Project site development may impact wildlife population sizes and increase the potential for population fragmentation, thereby reducing genetic diversity in populations. Increased access and use of the area may also increase hunting pressure on local wildlife populations. Potential effects of the Project on genetic diversity can be found in Section B.5.3.10. |

| Biophysical Factor | VCs Linked to Changes in Biophysical Factor | Summary of Interaction with Project |
| --- | --- | --- |
| | • Bat Community<br>• Bird Community<br>• Amphibian Community | |

### B.5.3 Potential Effects on Biophysical Factors

The sections below describe the potential effects of the Project on biophysical factors that support ecosystem function in the region, including residual cumulative effects and mitigation measures, as determined through the VC affects assessments in the Application/EIS. The results from the following VCs assessments were used to evaluate potential effects on biophysical factors that support ecosystem function:

- Atmospheric Environment (Chapter 6);
- Soil and Terrain Assessment (Chapter 8);
- Groundwater Assessment (Chapter 9);
- Surface Water Quantity Assessment (Chapter 10);
- Surface Water Quality Assessment (Chapter 11);
- Fish and Fish Habitat Assessment (Chapter 12);
- Landscapes and Ecosystems Assessment (Chapter 13);
- Vegetation Assessment (Chapter 14);
- Wildlife and Wildlife Habitat Assessment (Chapter 15); and
- Human and Ecological Health Assessment (Chapter 22).

#### B.5.3.1 Habitats Supporting Ecosystem Function

Habitats supporting ecosystem function represent unique or critical habitats at the regional or landscape level that support key ecosystem functions (EAO, 2020; U.S. EPA, 1999). Relevant Project VCs that support ecosystem functioning include avalanche chutes, grasslands, riparian habitat, old growth and mature forests, wetlands, and forests supporting federally-listed whitebark pine. Collectively, the Project is predicted to impact a total of 1,079 ha of these landscapes and ecosystems that support ecosystem function, including impacting:

- Approximately 69 ha of avalanche chutes;
- Approximately 12 ha of grasslands;
- Approximately 78 ha of riparian habitat;
- Approximately 919 ha of old growth and mature forest; and
- Approximately 0.69 ha of wetlands.

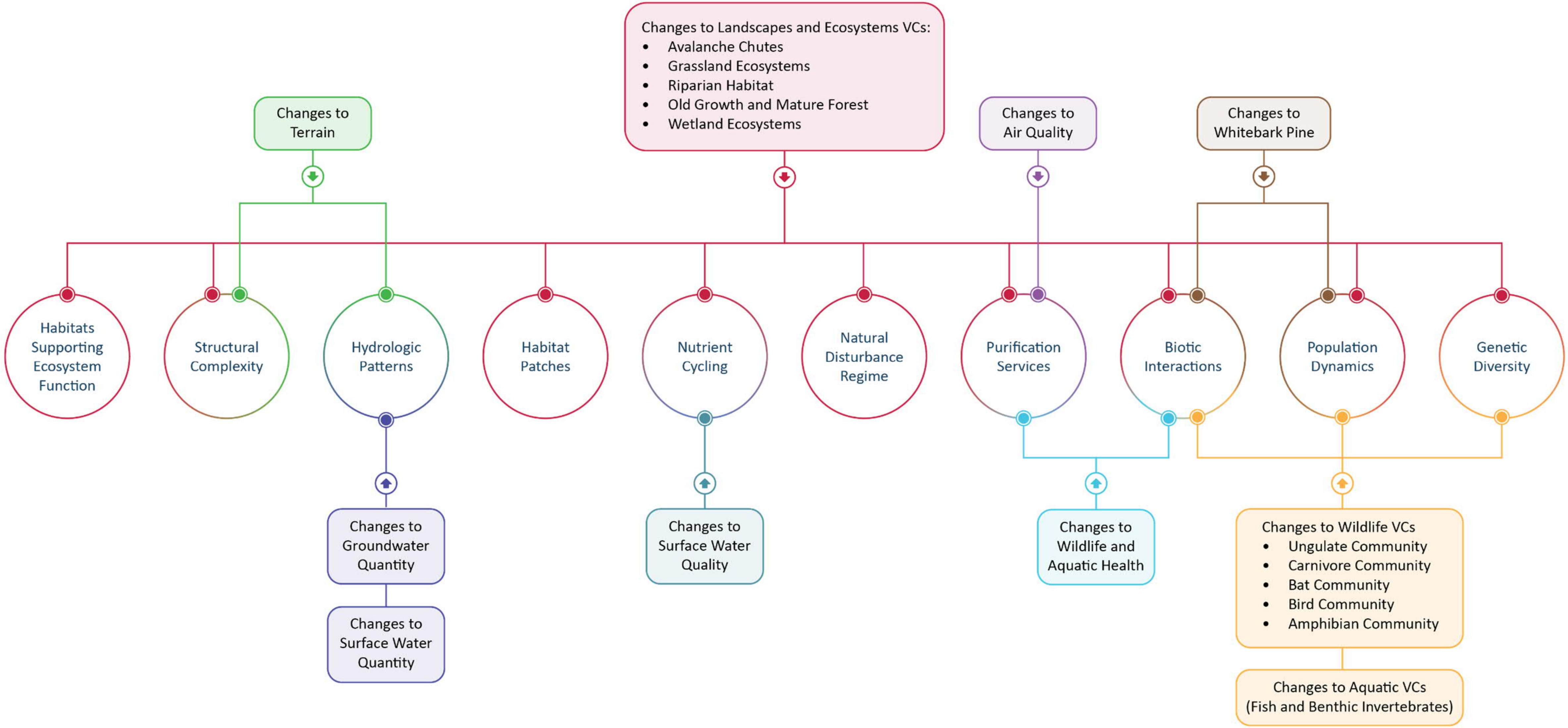


Figure B.5-1: Interactions Between Project Valued Components (VCs) and the Biophysical Factors that Support Ecosystem Function

#### B.5.3.1.1 Landscapes and Ecosystems

Habitats that provide ecosystem services include grasslands, riparian habitat, old growth and mature forests, and wetlands. These habitats are composed of sensitive, unique or rare species associations, or provide habitat for sensitive or rare species, positively contributing to the diversity of species and ecosystems in the landscape.

Grasslands are relatively uncommon, comprising less than 2% of the Landscape and Ecosystems LSA, and approximately 1% of the Project footprint. Implementation of the Ecological Restoration Plan will result in restoration of an estimated 181 ha of grassland habitat, which would represent a net increase of this uncommon habitat type within the Landscapes and Ecosystems LSA. Grasslands provide habitat for a rare vegetation community, the Red-listed ecological community Gg12 Rough fescue –(bluebunch wheatgrass) - yarrow - clad lichens (B.C. CDC, 2018) . The Gg12 ecological community occurs 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. Approximately 1.07 ha of the Project overlaps with this Red-listed ecological community.

Riparian habitats support fish habitat by providing shade to maintain cool water temperatures, stabilizing adjacent soils to prevent sedimentation of surface water, and providing leaf litter as a basal food and nutrient sources to lower trophic levels. The loss of approximately 36 ha of riparian habitat is associated with the infilling of West Alexander Creek as a result of the Project. In other areas, the loss of riparian habitat may impact channel morphology through increased bank erosion and sediment deposition into the channel. These effects can further lead to reductions in the availability of habitat type (e.g., overwintering and spawning habitat) supporting ecosystem function, fish, and aquatic community. Reclamation of riparian habitat will occur in some areas to reduce long-term impacts to habitat; however, the areas to be reclaimed are still to be determined.

Wetlands occupy an exceptionally small extent of the Landscapes and Ecosystems LSA (39 ha; less than 1%) and Project footprint (less than 1 ha; less than 1%). At a regional scale, wetlands are predicted to only occupy approximately 3,979 ha (1%) of the Landscapes and Ecosystems RSA. Given their relatively low abundance and extent at a local and regional level, wetlands are considered to be an uncommon habitat type, contributing disproportionately more to the diversity of habitats in the region. Furthermore, vegetation surveys confirmed 11 different Red- and Blue-listed vegetation communities, as well as two additional rare plant species at wetlands located in the Landscapes and Ecosystems LSA, providing disproportionately higher contributions to diversity than other more common, forested habitat types. No wetlands containing rare species or vegetation communities were identified within the Project footprint. Although wetlands contribute proportionally similar extents across the local and regional landscapes (i.e., approximately 1%), implementation of the Ecological Restoration Plan will reverse the Project-specific effects of wetland removal and restore wetland ecosystem services to the local area.

Project site preparation activities in Pre-Production and Construction and Operations have the potential to result in changes to the composition and integrity of landscapes and ecosystems through the introduction of invasive species, deposition of dust, and accidental release of deleterious materials where located adjacent to, or downstream from the Project footprint. Changes in composition and integrity of grasslands and wetlands would reduce these habitats' respective contribution to the diversity of vegetation in the Landscapes and Ecosystems LSA but are anticipated to predominantly affect herbaceous vegetation (in the case of introduced invasive species) with limited effect on trees and shrubs. Given that the ecosystem services of riparian habitat supporting fish habitat are largely based on the proximity and density of trees and shrubs to fish habitat, the effects are considered to be negligible and unlikely to affect the integrity of fish habitat downstream from the Project along the lower Alexander Creek, and the greater Elk River watershed. Through implementation of the recommended mitigation measures for the landscapes and ecosystems Project VCs, the residual effect on composition and integrity of grasslands and wetlands would be reduced, which over time would be reversed through monitoring and management practices.

#### B.5.3.1.2 Wildlife and Wildlife Habitat

Habitats within and surrounding the Project that provide high ecosystem functioning for wildlife include grasslands, avalanche chutes, riparian areas, old and mature forests and wetlands. Loss of these habitats could reduce suitable habitat within the Wildlife LSA for wildlife VCs; however, residual effects associated with the loss of habitat due to the Project in the Wildlife LSA were considered not significant. Impacts to grasslands (12 ha) and avalanche chutes (69 ha) will reduce the extent of foraging habitat for ungulates and grizzly bear, particularly during early (i.e., grasslands) and mid to late periods (i.e., avalanche chutes, riparian habitat) of the growing season. Further, the predicted loss of 78 ha of riparian habitat would adversely affect breeding habitat for birds, as well as summer and fall foraging habitat for grizzly bear and ungulates. Loss of old growth and mature forest would present a more extensive loss of year-round habitat for wolverine and American marten (i.e., 919 ha) relative to the total extent of the Project footprint. Given the common and extensive distribution of these habitats in the Landscapes and Ecosystems LSA and RSA (as well as "suitable habitat" within Wildlife LSA and RSA), habitat loss as a result of the Project is not predicted to result in a loss disproportionate to their regional abundance.

Wetlands do not comprise a large extent of the Project footprint (i.e., less than 1 ha). Although localized effects are anticipated through the loss of naturally occurring wetlands in the Project footprint, sustained populations of wildlife in these areas are exceptionally small (i.e., few to no breeding individuals) and do not act as primary congregation habitat for the bird migration season. Consequently, loss of wetlands providing habitat for wildlife in the Project footprint are considered to not be of material value in the greater regional landscape.

Wildlife may pass through the Project footprint for access between the West Alexander Creek and Grave Creek watersheds; however, there are no unique or distinct habitat types providing distinctive connectivity across, or acting as a central congregation point within, the Project footprint. Riparian habitats (78 ha) along West Alexander Creek and its tributaries would be lost within the upper reaches of the watershed; however, these habitats do not provide material connectivity across the landscape, with remaining riparian habitat areas within the lower Alexander Creek watershed remaining intact.

Restored ecosystems as part of the Ecological Restoration Plan will support foraging needs and wildlife movement through the creation of high and low elevation forests, grasslands, whitebark pine dominated forests, sparsely vegetated talus, riparian habitat and wetland ecosystems. In particular, the restoration during Reclamation and Closure is anticipated to restore approximately 181 ha of grasslands and 19 ha of riparian habitat. Although restoration of avalanche chutes is not planned as part of the Ecological

Restoration Plan, it is expected that the restored high elevation forests within the run-out zones from avalanche chutes upslope from the Project footprint will restore to similar conditions. Restoring old growth and mature forest will take considerably more time, given the time needed to achieve the structural conditions suitable for target species (e.g., wolverine and American marten). The Project footprint is ultimately expected to be a landscape similar in structure and composition to the pre-Project landscape.

The Project is not proposed to remove a disproportionately large extent of habitats supporting ecosystem function relative to that available in the Landscape and Ecosystems LSA (nor contribute disproportionately to cumulative loss in the Landscape and Ecosystems RSA), nor are there any unique or distinctive habitats supporting wildlife movement or congregation. Given that the effects to these habitats supporting ecosystem functions associated with wildlife foraging, breeding, and movement are confined to the upper West Alexander Creek watershed, they are not likely to contribute to cumulative effects on wildlife in the greater landscape of the Elk Valley.

#### B.5.3.1.3 Whitebark Pine

Whitebark pine is listed as Endangered under Schedule 1 of the *Species at Risk Act* and designated on the Blue-list in British Columbia (ECCC, 2017; B.C. CDC, 2020). Habitats supporting whitebark pine were predicted to occupy up to 591 ha (46%) of the Project footprint and 1,375 ha (11 %) of the Landscapes and Ecosystem LSA. Although habitat-specific mapping is not available for the greater Elk Valley, proposed critical habitat for whitebark pine (Environment and Climate Change Canada, 2017) occupies up to 236,671 ha (67%) of the Landscapes and Ecosystems RSA. The Project footprint intersects as much as 1,176 ha of the critical habitat proposed; however, Project-specific analysis confirmed the actual extent will be closer to 802 ha, or less than 1% (i.e., 802 ha of 236,671 ha) of the total extent of potential whitebark pine critical habitat in the Landscapes and Ecosystems RSA.

Whitebark pine is at risk of significant population declines due to the potential effects of climate change and the spread of whitebark pine blister rust, predicted to affect up to 100% of the national population in Canada (ECCC, 2017). ECCC (2017) proposes that mining in B.C. will pose a “negligible” impact, affecting less than 1% of the national population of whitebark pine. The Project’s Ecological Restoration Plan will restore whitebark pine dominated forests within the Project footprint; however, the ecological restoration will not likely restore all potential habitat for whitebark pine as compared to baseline conditions. The Project’s respective contribution to impacts on habitat for whitebark pine are exceptionally low given the extent of available habitat (and Critical Habitat) elsewhere in the Landscapes and Ecosystems RSA. Restoration of whitebark pine habitat is dependent upon successful propagation and reintroduction, which continues to undergo experimental development at this time. Regardless of the potential residual effects on the habitats that support ecosystem function, including vegetation and ecosystem diversity, their relative cumulative effect in the greater landscape of the Elk Valley is anticipated to be minimal.

### B.5.3.2 Habitat Patches

The size, number, quantity, and distribution of habitat patches across the landscape support the movement of species and the transfer of energy and nutrients among habitats (EAO, 2020). Fragmentation of habitat into disconnected and isolated patches can disrupt ecological integrity, with edge effects further reducing the ecological function of habitat patches (EAO, 2020; U.S. EPA, 1999). In the Elk Valley, habitat fragmentation has occurred due to settlement, mining, forestry, linear disturbance, wildfires and fire suppression, insect outbreaks, agriculture, and recreation and tourism. These activities have resulted in disconnected and isolated patches of habitats supporting ecosystem function, affecting the abundance and distribution of wildlife. The development of the Project in the Elk Valley, in particular site preparation and construction activities, has the potential to further fragment existing habitat and ecosystems. Reduction of habitat patches across the landscape may reduce the abundance and distribution of wildlife.

#### B.5.3.2.1 Landscapes and Ecosystems

The Project has a disturbed area of 1,283 ha. The total area estimated to be impacted as a result of Project development is approximately 850 ha of direct soil and vegetation impacts with a buffer area around areas directly impacted to account for uncertainty in precise boundaries of disturbance. Not all of the buffer areas will be cleared. Removal of the ecosystems through site development (e.g., site clearing) in Construction and Pre-Production is anticipated to result in residual effects on ecosystem abundance and distribution as well as ecosystem composition and structure. Through the removal of landscapes and ecosystems in Construction and Pre-Production, namely avalanche chutes, riparian habitat, and old growth and mature forests, some fragmentation of existing habitats may occur in the area within and surrounding the Project until ecosystems are progressively reclaimed as part of the Ecological Restoration Plan and the Landform Design and Reclamation Plan. Indirect edge effects may also occur in Construction and Pre-Production as well as Operations and occur as a result of site clearing, vehicle traffic, soil movement, and the spread of invasive plant species. Plant vigour in vegetated habitats adjacent to the Project footprint, including access roads and waste rock areas, may be reduced as a result of the introduction and/or spread of weeds and invasive plants and the deposition of sediments and dust.

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). Majority of the Project footprint is characterized by old growth and mature forest, indicating a loss on the landscape of a larger forest patch over the course of Project development. Grizzly bears generally forage in areas of open canopy, partial forest, or older forests with many tree gaps due to the higher vegetation productivity (Gyug et al., 2004; Proctor et al., 2015; Mowat et al., 2020b) while wolverines predominantly use mature and old growth forest for denning habitat and bats using these stands for maternity roosts and hibernacula.

The Project's Ecological Restoration Plan will assist in reducing the net effect of ecosystems impacted as a result of the Project; however, not all landscapes and ecosystems VCs can be restored to baseline conditions. The Ecological Restoration Plan will restore approximately 750 ha within the Project development footprint and will create high and low elevation forests, grasslands, whitebark pine dominated forests, sparsely vegetated talus, riparian habitat and wetland ecosystems. Access roads (e.g, Valley Road and Grave Creek Road) will remain as permanent features in the Post-Closure mine environment.

#### B.5.3.2.2 Wildlife and Wildlife Habitat

The temporary reduction of the use or crossing of habitat patches across the landscape may reduce the wildlife abundance and distribution within and surrounding the Project. The Project was predicted to result in residual effects to wildlife habitat through habitat loss and degradation and disruption to movement; however, these effects were determined to not be significant. The Project is not expected to result in a high degree of habitat fragmentation compared to linear developments in the Elk Valley as the Project footprint is primarily constrained to the small shallow coal deposit outcrop adjacent to the Alexander Creek Syncline. The Project includes upgrades to Grave Creek road as the haul road, which is known to be crossed by several wildlife species (e.g., bighorn sheet) in their movement across the Grave Creek Canyon. Linear features, such as roads, create unique edge effects due to increased vehicle traffic, which can further degrade habitat quality for wildlife (Holmes et al., 2018).

Edge effects on the landscapes and ecosystem VCs surrounding the Project may result from invasive species encroachment and reduced plant availability due to dust deposition. As well, surface water run-off from the Project may result in suspended solids and affect vegetation grazed or inhabited by wildlife. Edge effects in habitat patches surrounding the Project may reduce the availability of wildlife forage habitat. Sensory disturbance associated with noise, and lights over the course of the Project reduce functional use of habitats immediately surrounding the Project by wildlife, including changes to wildlife movements, foraging, breeding, and avoiding predators.

#### B.5.3.3 Natural Disturbance Regime

Anthropogenic activities have potential to alter natural disturbance regimes by changing the frequency of disturbance, usually achieved through prevention or suppression measures. Fire suppression, flooding control measures and avalanche control can all reduce the frequency of stand-replacing events that sustain grasslands, floodplains and avalanche chute habitats. Alternatively, human activities may increase the frequency or severity of disturbance through vegetation clearing and management practices. For example, sites with typically low frequency of disturbance, resulting in development of old and mature forests, can experience an increased frequency of disturbance through vegetation clearing and management (e.g., along power distribution lines and road ditches) during construction and operations.

##### B.5.3.3.1 Fire

Given the extent of existing fire prevention and control practices in the region, and that the Project will generally remove all fire fuel (i.e., woody vegetation) within the Project footprint, it is unlikely that the Project will result in a change in the frequency of stand-replacing fire events. Safe work practices and removal of vegetation within workspaces will prevent an increase in fire risk. Although some fire prevention and suppression measures are likely to be deployed to protect the Project facilities, these measures are anticipated to be restricted to the Project footprint and immediately adjacent lands surrounding the Project. The Project footprint may act as a barrier to fire movement across the landscape, which would reduce the frequency of stand replacing events; however, this would only be due to migration of fire from other start locations; the Project is not expected to alter the likelihood of a fire starting due to natural causes (e.g., lightning) within the landscape. Given these factors, the Project is not likely to alter natural disturbance regimes associated with fire.

##### B.5.3.3.2 Avalanche

The Project is anticipated to alter natural disturbance regimes associated with avalanche activity within, and immediately adjacent to the Project footprint. Not only will the Project require removal of run-out zones from avalanche chutes, but safe operation of the Project may require further control of avalanche risk in areas upslope of the Project footprint. Restoration of avalanche chutes at the time of Project closure is not planned; however, it is expected that restored “high elevation forests” downslope of start zones from avalanche chutes upslope from the Project footprint will restore to similar conditions after avalanche control measures cease.

In addition to Project-related alteration of avalanche-generated natural disturbance regimes, forecasted modelling for the Elk Valley indicates that climate change is likely to result in altered potential for avalanche, through 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.

##### B.5.3.3.3 Flooding

Construction of the Project and installation of water control structures will reduce the frequency and variability of discharge contributing to natural disturbance regimes along lower Alexander Creek. Given the hydrologic context of Alexander Creek, there is little development of floodplains within the respective riparian zone that would depend on release of floodwaters from West Alexander Creek under baseline conditions. Consequently, construction of the Project and operation of water control structures at West Alexander Creek are not anticipated to result in any changes to natural disturbance regimes in this watershed.

Larger floodplains are predicted to occur along the Elk River, south of its confluence with Grave Creek. Due to the relatively small footprint of the Project, and implementation of mitigation measures to dissipate increased energy of water flowing along ditches along the Grave Creek Forest Service Road, construction and operation of the Project is not anticipated to affect the natural disturbance regimes affecting flood plains along the Elk River.

#### B.5.3.4 Structural Complexity

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. While the Project is predicted to reduce structural complexity within the LSA particularly due to the removal of riparian habitat and old growth and mature forests, the Project does not have a disproportionately higher potential effect on structural complexity in comparison to other developments.

##### B.5.3.4.1 Landscapes and Ecosystems

Within the Landscapes and Ecosystems LSA, 7% (78.39 ha) of the riparian habitat will be removed as a direct overlap with components of the Project footprint through a reduction of riparian ecosystem abundance and distribution through logging, clearing, grubbing, and soil salvage, as well as through reduced surface water quantity. This removal of riparian vegetation will impact habitat complexity and structure through both the direct removal of vegetation, as well as reducing riparian inputs to instream habitat complexity (e.g., CWD). Herbaceous and shrubby species will restore quickly, but the restoration of tree species and CWD could take up to 140 years.

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. Wetlands directly affected by the Construction and Pre-Production phase include 0.27 ha of marsh and 0.42 ha of shallow open water. The direct effect on 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. This will remove spatial heterogeneity between the wetlands and boarding ecosystems in this area through which there was energy transfer through predator-prey relationships, decreasing the structural complexity of this area until restoration.

Permanent loss of old growth and mature forest due to clearing and grubbing (up to 919 ha) will largely occur in the Construction and Pre-Production and Operations phases. 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 with the remaining 669 ha expected to be lost progressively through clearing over the 15 years of operations through the loading, hauling, and stockpiling of soil and mine rock. Further the 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, of which 249 ha has been designated as non-legal Old Growth Management Area. The loss of old growth forest will contribute to a loss in structural complexity in the region as large trees, snags, and fallen trees play a critical role in the presence of microclimate, food abundance, and cover which are important contributors to structural complexity (Cody, 1985; Maser et al., 1988). 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 largely affecting cumulative structural complexity in the Landscapes and Ecosystems RSA.

#### B.5.3.5 Hydrologic Patterns

The movement of water through ecosystems provides a crucial resource to biotic and abiotic components. Potential effects of the Project on surface water quantity are associated with pit development and dewatering, changes in drainage patterns and groundwater-surface water interactions, and water table changes in proximity to the pits. The Project effect on groundwater quantity is predicted to be a reduction of baseflow in the range of 5% from baseline at Alexander Creek, and 2% at Grave Creek. Impacts to baseline flow are estimated to be greatest in West Alexander Creek with baseflow reductions up to 30% during the End of Mining (EOM) stage.

Effects on groundwater quantity are expected to decrease with increasing downstream distance in the Alexander Creek and Grave Creek valleys as the catchment area gets larger and surface water flow rates (thus potentially groundwater recharge) generally increase. No significant changes are expected to groundwater flow direction to the north of the proposed mining area and to the south of the confluence between Upper Alexander and West Alexander Creeks that may disrupt the hydrologic patterns including cumulative interactions with effects from other operations.

As the Project will involve changes to land use and hydrology, predicted effects to surface water quantity include a reduction in the projected annual flows (minimum, average, and maximum values). The most notable reduction, of up to -40% of surface flows during the Post-Closure phase, occurs on West Alexander Creek downstream of the Main Sediment Pond Outlet. As water travels downstream, however, reductions in mean monthly surface flow become less in magnitude with flows in Grave Creek, upstream of the Elk River reduced by -1.6% to 0.1% across all project stages. In Alexander Creek, downstream of Harmer Creek, flows are predicted to decrease between -1.9% to 0.3%. Although the Project may result in localized reductions on surface water quantity, residual effects related to site construction, operation, mine closure and reclamation activities are not considered significant at downstream extents of the LSA. As impacts are projected to decrease with increasing distance downstream, fluvial regimes and geomorphic conditions contributing to the hydraulic patterns of the landscape are not anticipated to be altered. The predicted change in surface water quantity, including cumulative interactions with effects from ongoing operations mining operations and other industry indicate a negligible (ie., <1% change from baseline) change in mean annual and mean monthly flows during all Project phases at multiple nodes within the Aquatic RSA. Minimal change to surface water quantity is unlikely to affect the surface water hydrologic patterns within the watershed.

#### B.5.3.6 Nutrient Cycling

Nutrient cycling refers to nutrient flows into and out of an ecosystem. Nutrient cycling, in combination with sunlight and water, determines the productivity of an ecosystem. Reduction or addition of nutrients to ecosystems can alter natural trophic structure and resiliency, affecting the quality of the natural environment. Nutrients such as nitrogen and phosphorus can cycle in an ecosystem through land cover alterations and aquatic channel alterations. Nutrients entering terrestrial receiving environments contribute to plant assemblage structures which are food resources and habitat structures for various trophic levels. In aquatic environments, nutrients are required for the growth of macrophytes, periphyton, and phytoplankton which contribute to dissolved oxygen levels in rivers and streams providing the necessary life sustaining conditions for fish.

The Project may impact nutrient cycling by altering or removing terrestrial and aquatic ecosystems in the vicinity of the Project which store and cycle nutrients or by discharging contaminants to terrestrial and aquatic ecosystems. Changes to nutrient cycling can affect trophic structure and resiliency by limiting growth due to nutrient deficiencies and changes in nutrient flow through ecosystems. Site development activities may affect nutrient cycling due to:

- The loss of aquatic habitat including riparian areas;
- The loss and/or disturbance of terrestrial habitat (including removal of vegetation [e.g., old growth and mature forest], disturbance of soils);
- The loss of wetlands and/or disturbance of wetland function;
- Impacts/changes to surface water quality; and
- Changes to water movement, influencing downstream nutrient transport.

##### B.5.3.6.1 Riparian Habitat

Riparian habitats can provide instream cover and habitat diversity, transfer nutrients, and increase food sources from both vegetation and invertebrates present in these areas. The riparian zone introduces leaf litter into the aquatic environment providing a food and nutrient source to lower trophic levels (periphyton, benthic invertebrates) within the aquatic system

The Project is anticipated to result in an estimated removal of approximately 78 ha of riparian habitat, including 36 ha associated with West Alexander Creek. The removal of riparian vegetation has the potential to reduce riparian-related nutrient inputs to downstream areas of watercourses such as Alexander Creek. Using the thresholds for ranking the level of hazard associated with the extent of loss of riparian habitat provided for by the EV-CEMF (Davidson et al., 2018), the reduction of riparian habitat associated with construction of the Project footprint was classified as a low risk. While there are expected to be some local impacts to riparian areas (e.g., West Alexander Creek), no cumulative effects to the cycling of nutrients through the aquatic food web would be expected at the landscape/watershed level. Upon Reclamation and Closure, and with the initiation of site reclamation activities (including the implementation of an approved fish habitat offsetting plan), it is expected that stream side herbaceous and shrubby species will restore quickly.

#### B.5.3.6.2 Surface Water

Permitted seepage and effluent discharges have the potential to introduce nutrient loads (e.g., nitrate) to surface waters. Surface water was assessed at key locations within the Project footprint, Aquatic LSA, and Aquatic RSA, including the development of a site-wide water and load balance model to evaluate surface water quality under existing and proposed mine development scenarios. Modeling indicated that median nitrate concentrations in West Alexander Creek are not predicted to exceed B.C. Water Quality Guidelines (WQG; ENV, 2019) for nitrates throughout the duration of the Project. Potential impacts to nitrate concentrations at a watershed level are not expected to occur. Median nitrate concentrations in Alexander Creek are predicted to remain well below the B.C. WQG throughout all phases of the Project show minimal deviation from background levels at all Alexander Creek nodes in both assessment scenarios.

Localized erosion and sedimentation may occur as a result of site clearing activities and vegetation removal, which could potentially result in increased suspended solids with watercourses. In addition, flows entering West Alexander Creek from the sediment ponds also have the potential to result in erosion to the natural creek bed, causing additional suspended solids loads downstream; however, it is expected that potential erosion and introduction of sediments to aquatic systems can be controlled using a wide range of well-established and tested mitigation measures.

Calcite formation can also change the characteristics of stream substrates by cementing rocks together, adversely affecting habitat for fish and invertebrates, including the cycling of nutrients with watercourses. A calcite assessment was completed which indicates that calcite formation would be localized and form primarily in West Alexander Creek to the confluence with Alexander Creek.

#### B.5.3.6.3 Landscapes and Ecosystems

Grasslands

Grassland habitats store nutrients such as carbon in their stalks, leaves and roots, and uptake phosphorus and nitrogen from the soil. The most extensive low elevation grassland within the Landscapes and Ecosystems RSA is found at Grave Prairie, a level river terrace located south of the confluence of Grave Creek and the Elk River. The Project is predicted to impact approximately 12 ha of grasslands as a result of site clearing and grubbing activities in Construction and Pre-Production. 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, increase potential for soil erosion, alter the plant species assemblages and community structure, and alter the ecological community's ability to recover from disturbance, all of which have the potential to impact grassland ecosystems' capacity for nutrient storage.

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 cumulative long-term viability and persistence of grassland ecosystems at the landscape and ecosystem level. Further, 181 ha of grasslands will be restored in the Project footprint during site Reclamation and Closure as part of the Ecological Restoration Plan.

### Old Growth Forests

Old growth forest ecosystems store nutrients (i.e. atmospheric carbon dioxide [$CO_2$]) through sequestration, producing oxygen and fixing nitrogen from its elemental form to compounds such as ammonia or nitrous oxide (Luyssaert et al., 2008). The function of carbon storage by old growth forests contributes to the stability of atmospheric CO2 levels, as well as to the fixation of nitrogen and phosphorus through root systems and leaf litter.

The Project is predicted to impact approximately 919 ha of old growth and mature forest due to logging, clearing, and grubbing activities, with most of the area located in upper alpine regions, where structural complexity is limited to shrub, krummholz and sparse parkland types with single or non-existent forest canopies. The loss of old growth and mature forest is expected to contribute to a localized reduction in nutrient cycling within terrestrial habitats within the Project footprint due to the loss of trees, vegetation, snags, root systems, leaf litter, and soils and debris (and associated organisms) which all play a role in the movement of nutrients and cycling within in this ecosystem. While there may be some localized effects to nutrient cycling within forest habitat, it is not expected that the Project will result in disproportionately large impacts to overall nutrient cycling at the landscape and ecosystems level. Although the Project is expected to remove areas of old growth and mature forest, areas will be reclaimed and revegetated within the Project footprint as a result of progressive reclamation activities over the course of the Project. While it is recognized that restoring old growth and mature forest will take decades, initial revegetation activities will initiate the enhancement of nutrient cycling in the area.

### Wetland Ecosystems

Wetlands cycle nutrients through abiotic and biotic processes, such as the 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, and production of soils. Wetlands can function as sinks, sources, and transformers of nutrients, organic matter, and other materials. A total of 0.69 ha of wetland area (0.16% of wetland ecosystems within the Terrestrial LSA will be permanently lost within the Project footprint as a result of activities carried out in the Construction and Pre-Production phase. The direct effect to wetlands includes the loss of wetland vegetation and vegetation complexes, loss of wetland soils, and loss of wetland catchment/drainage areas connected to the Alexander Creek watershed. As part of compensation efforts, site reclamation activities include the creation of wetland habitat including swamp, marsh, and shallow open water areas.

The small area of wetlands impacted by the Project do not play a significant role in the cycling of nutrients in the greater landscape. 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 at the landscape level are not anticipated to affect the long-term viability of wetland ecosystems in the Elk Valley.

#### B.5.3.7 Purification Services

Purification processes are necessary for the functioning of ecosystems by contributing to the detoxification of harmful materials and re-fertilizing soils and sediments through the actions of microbes and other organisms (U.S. EPA, 1999). Within and surrounding the Project, purification services are largely provided by forests, wetlands, and the riparian habitat adjacent to watercourses. Pathways where chemical contaminants may enter the landscape as a result of the Project may include:

- Atmospheric emissions and fugitive dust;
- Contact of water with Project infrastructure, including surface water run off and transporting ions and metals into watercourses; and
- Permitted effluent discharge.

##### B.5.3.7.1 Air Quality

Air emissions resulting from Project activities such as the construction of facilities and infrastructure, construction and upgrading of access and haul roads, blasting, transportation of soil, raw coal, mine rock, and coal rejects, use of heavy equipment, and operation of vehicles have the potential to affect air quality due to the generation of fugitive dust and other criteria air contaminants (CACs) such as NOx, CO, and $SO_2$ during all phases of the Project. Dispersion modelling results indicate that exceedances will occur; however, the changes in ambient air contaminant concentrations will not be significant. As most sensitive receptors are located within 2 km of the Project footprint, exposure to humans and wildlife is possible; however, continuous exposure is not anticipated and exceedances are not expected to be widespread in the local area. Similarly, fugitive dust is anticipated to be highest from the unpaved haul road; however, is not anticipated as a significant effect and the Project-related risk to wildlife or human health is considered to be low. Deposition is anticipated to have limited exposure due to locations occurring within the Project footprint or adjacent to the mine access roads (e.g., unpaved haul road).

The expected greenhouse gas emissions from the Project will be measurable and may carry importance in local and provincial GHG emissions, contributing to global climate change at the transboundary level. Purification services offered by old growth forests offer purification services in the form of carbon sequestration and the ability to store atmospheric $CO_2$. Although the Project is expected to remove 919 ha of old growth and mature forest, carbon sinks will gradually be re-established within the Project footprint as a result of progressive reclamation and revegetation during Operations and Reclamation and Closure, resulting in a positive effect on greenhouse gas concentrations.

##### B.5.3.7.2 Landscapes and Ecosystems

Approximately 78 ha of riparian habitat, comprising 7% of riparian habitat in the Landscapes and Ecosystems LSA, is anticipated to be lost as a result of the Project. While 36 ha of riparian habitat is associated with the loss of the instream habitat of West Alexander Creek, areas with impacted riparian habitat may experience a change in purification services. Areas with riparian habitat loss may experience an increase in soil erosion and its associated impacts on surface water quality due to increases in turbidity and total suspended solids. Although the impact to riparian habitat is considered to be localized and of low magnitude, the loss of riparian habitat is permanent and potentially irreversible. Some areas with impacted riparian habitat may be reclaimed and therefore reduce the localized impact to surface water.

Construction and Pre-Production phase activities, including clearing and grubbing, logging, and salvaging of wetland soils, are anticipated to result in the loss of 0.69 ha (0.16%) of wetlands in the Terrestrial LSA. The loss of the marsh and shallow open water wetlands may reduce purification services including carbon sequestration and storage and filtration of water. In the Reclamation and Closure phase of the Project, reclaimed and newly constructed wetland ecosystems created will contribute up to 10 ha of a functioning wetland ecosystem by the end of the Post-Closure phase. Reclamation and increase of wetlands on the landscape will provide a net positive contribution to the landscape, supporting the replenishment of purification services to the local area, although not all functions may be replaced.

#### B.5.3.8 Biotic Interactions

Direct and indirect changes to terrestrial and aquatic ecosystems and the habitat provided by these ecosystems may impact biotic interactions at a landscape and/or watershed level. The Project is predicted to influence biotic interactions through the loss of aquatic and wildlife habitat with the potential for indirect changes from increased use of access roads (e.g. Grave Creek Road) and higher wildlife mortality.

##### B.5.3.8.1 Fish and Fish Habitat

The Project is anticipated to result in the loss of up to 31,928 $m^2$ of fish-bearing habitat in West Alexander Creek. The loss of fish habitat in West Alexander Creek has the potential to cause an imbalance in the aquatic food web due to the reduction of invertebrate drift. Invertebrate drift refers to the in-channel, downstream transport of terrestrial and aquatic invertebrates, and is an important food source for insectivorous fish species, including Westslope Cutthroat Trout (Shepard et al., 1984; Wipfli and Gregovich 2002; Naman et al. 2016). Up to 80% of the invertebrate drift community has been documented to be reduced by fish consumption (Naman et al., 2016). Although the loss of fish habitat in West Alexander Creek will affect the biomass of invertebrates available, the reduction of short range drift is anticipated to have a minimal effect on consumers and will be limited to the upstream sections of Alexander Creek. As drift-feeding fish further downstream of West Alexander will likely continue to rely on more local sources of invertebrates, the potential cumulative impact on the aquatic food web and productivity is anticipated to be minor.

As noted in Section B.5.3.6, the Project may result in an estimated removal of approximately 78 ha of riparian habitat, including 36 ha associated with West Alexander Creek. Removal of riparian habitat over the course of the Project, in particular in Construction and Pre-Production, may reduce instream habitat features and complexity (e.g., CWD, pools, and substrates) as well as reduce habitat diversity and food sources from both vegetation and invertebrates. Reductions in riparian habitat, and the associated potential effects of bank erosion, have the ability to impact channel morphology, potentially reducing presence of pools that may be used by the fish community as overwintering habitat, and increase the potential for fine sediment to infill areas previously dominated by coarse substrates. Infilling of the interstitial spaces of gravel and other coarse substrates can substantially reduce available spawning habitat. In addition, the reduction of riparian habitat may also reduce the availability of cover (e.g., shading, large woody debris) which may in turn lead to reduced instream habitat quality for fish to carry out their life history stages.

Riparian habitat introduces leaf litter into the aquatic environment providing a food and nutrient sources to lower trophic levels (e.g., periphyton, benthic invertebrates) within an aquatic ecosystem. Riparian habitat along West Alexander Creek and its tributaries would be lost within the upper reaches of the watershed; however, these habitats do not provide material connectivity across the landscape, with remaining riparian habitat areas within the lower Alexander Creek watershed remaining intact.The removal of riparian habitat along West Alexander Creek is not expected to result in downstream changes in the biotic interactions and trophic levels of the Alexander Creek system and as such, no impacts to lower trophic levels are anticipated outside of the removal riparian habitat in West Alexander Creek. Upon Reclamation and Closure, and with the initiation of site reclamation activities (including the implementation of an approved fish habitat offsetting plan), it is expected that stream side herbaceous and shrubby species will restore quickly through implementation of the Ecological Restoration Plan.

#### B.5.3.8.2 Wildlife and Wildlife Habitat

Interactions of keystone species are particularly important in maintaining ecosystem structure and function (U.S. EPA, 1999). Species of importance which influence interactions within and surrounding the Project include top predators such as grizzly bear and Canada lynx. Due to the large space requirements of carnivores and their naturally low population densities and reproductive rates, carnivores are sensitive to landscape change resulting in habitat loss (including loss of prey), habitat fragmentation (i.e., loss of connectivity), and mortality (Carroll et al., 2001; Ripple et al., 2014).

Removal of landscapes and ecosystems within the Project footprint may result in the loss of wildlife habitat through the Construction and Pre-Production and Operation phases. Loss and degradation of wildlife habitat within the Project footprint may result in localized impacts to wildlife foraging, reproduction, and/or movement. Physical disturbances within the Project footprint, including ground disturbance and vegetation clearing, can cause direct loss of ecosystems and the corresponding resources they provide. A loss of key resources required to fulfill life requisites can result in reduced body condition, survivorship, and reproductive success of wildlife species. Carnivores may respond to habitat alteration by reducing their use of areas, avoiding habitats for a period of time (i.e., displacement), or abandoning portions of their current range. The potential effects of habitat alteration may be particularly high when Project activities in Construction and Pre-Production are within or adjacent to seasonally limiting habitats such as breeding areas. Habitat loss and degradation within the Project footprint may also affect wildlife use of trails and movement routes connecting seasonal or daily habitats.

The Project footprint overlaps with high-quality grizzly bear habitat and Canada lynx habitat. The Project will result in a predicted loss of up to 228 ha (in fall) of high-quality grizzly bear habitat, representing a loss of up to 3.7% of the total amount of high-quality grizzly bear habitat available in the Terrestrial LSA (6,195 ha). For Canada lynx, the Project will result in a predicted loss of up to 1,159 ha of high-quality Canada lynx habitat, representing a loss of 6.5% of the total amount of high-quality Canada lynx habitat available in the Terrestrial LSA (17,721 ha). High-quality habitat loss will be in various portions of the Project footprint including the rail loadout, the utility corridor, upper and lower access roads, the mine site and the conveyor. On a proportional basis, the availability of high-quality grizzly bear habitat is lower within the Project footprint compared to the Terrestrial LSA as whole (0 to 18% for the Project footprint and 13 to 27% for the Terrestrial LSA, depending on the season), meaning high-quality habitat is more common outside the footprint than it is within. For Canada lynx, the availability of high-quality Canada lynx habitat is higher within the Project footprint compared to the Terrestrial LSA as whole (90% for the Project footprint and 73% for the Terrestrial LSA). Based on the characterization of the residual effects, the Project is not expected to limit the ability of carnivores to persist and maintain self-sustaining populations in the Terrestrial LSA. The residual effects of habitat loss and degradation, sensory disturbance, and disruption to movement on wildlife VCs are therefore considered not significant.

Through implementation of the Ecological Restoration Plan in Reclamation and Closure, a mosaic of coniferous forest, open alpine tundra, rock outcrops, shrub and graminoid dominated brushland, talus slopes, wetlands and riparian areas will be restored on the landscape. The restored ecosystems will provide habitat for carnivores (i.e., food, security, or thermal protection) over time. Within five years of closure, graminoids, forbs, and some shrubs will have become established and will begin to provide food for wildlife, though the quality will be variable and may be limited in many areas. Grizzly bears have been found to access reclaimed mines to forage on vegetation and prey on ungulates (Cristescu et al., 2011); however, mine reclamation areas have generally not been found to support high value forage used by grizzly bears (Teck Coal Limited, 2014; Mowat et al., 2018). Food availability for wildlife VCs will progressively improve at 25 and 50 years post-closure and forests will begin to become established at 50 years post-closure onward, especially at low elevations, and begin to provide security for wildlife species. The Project footprint is ultimately expected to be a landscape similar in structure and composition to the pre-Project landscape.

#### B.5.3.9 Population Dynamics

In the Elk Valley, wildlife populations have been historically influenced by both natural- and human-influenced processes and continue to be to the present day. Natural processes influencing population dynamics include competition for resources between different species (e.g., moose, elk, mule deer), natural disturbance regimes (e.g., fire, flood, avalanche) reducing habitat or directly affecting population numbers through mortality. Anthropogenic influences in the vicinity of the Project include the development of linear corridors, such as highways, which can decrease suitable habitat for life processes of species such as mating and rearing of young, as well as directly contribute to population decreases through human-animal interactions (e.g. motor vehicle accidents, hunting pressure). Within the landscape, the Project may contribute to changes in population dynamics as a result of the direct loss of aquatic and terrestrial ecosystems, with the reduction in habitat availability potentially adversely affecting life-history characteristics. As well, indirect effects of the Project, including use of access roads over the course of the Project, may increase the risk of wildlife mortality due to collisions with Project-related traffic.

##### B.5.3.9.1 Fish and Fish Habitat

Development of the mine site will result in the removal of approximately 5.5 km of West Alexander Creek and the direct loss of instream habitat for the aquatic community including benthic invertebrates and the resident population of Westslope Cutthroat Trout. As part of the mitigation measures for fish populations, fish will be relocated downstream via catch and release activities (i.e., fish salvages) and therefore potentially introducing them to other sections of the Alexander Creek watershed. Once relocated, fish may disperse beyond their previous ranges and be subject to competition with other fish and fish species for habitat and food resources and thereby create changes in the population dynamics of the fish community. Depending on the abundance and dispersion range of the species, these changes may be limited within Alexander Creek, or with increased mobility may extend further downstream to connected habitats.

##### B.5.3.9.2 Wildlife and Wildlife Habitat

Linear corridors across the Elk Valley, including roads, highways, and railroads, have increased mortality risk of wildlife through direct collisions with vehicles or trains and indirectly by increasing hunter access and facilitating predator movement. Although the Project will be using existing access roads (e.g., Valley Road and Grave Creek Road), the increased use of these roads as a result of the Project has the potential to increase the mortality risk to wildlife VCs. Increased mortality may result from collisions with Project-related traffic during site preparation and clearing activities and collisions with Project-related traffic on access or mine site roads. As well, wildlife mortality has the potential to occur as a result of entrapment during avalanche controls or along access roads during winter due to high snowbanks.

The increased mortality risk of wildlife associated with potential collisions with Project-related traffic on access roads, collisions with trains, and increased hunter access are not likely to be fully mitigated through the Project's mitigation and management planning; however, collisions with wildlife along access roads have a low likelihood of occurring. The predicted Project traffic level of 140 vehicles per day is unlikely to affect crossing success, especially with speed reductions in areas known to have frequent wildlife (e.g., Grave Creek Canyon) and that wildlife have the right-of-way. There will be an incremental increase in rail traffic on the main rail lines as a result of the Project (one additional train every three days on average) where the risk of wildlife-train collisions is higher.

The Project has the potential to create physical and/or sensory barriers that prevent or impede movements between daily or seasonal habitats which could result in changes to wildlife behaviour, causing individuals to lose time and energy normally allocated towards accessing forage and prey, breeding, and avoiding predators. Some carnivore VCs exhibit seasonal movement patterns that are largely driven by food availability (e.g., grizzly bear, wolverine, and Canada lynx). When the Project is at its largest extent and prior to any large areas of reclamation (around Year 10 of Operations), the mine site footprint will occupy a large portion of the West Alexander Creek valley and will be an impermeable barrier in the area that it occupies. The upper slopes of the west side of the valley will remain intact, but will be degraded by sensory disturbance and use for connectivity between daily or seasonal wildlife habitats may be reduced. The conveyor is expected to represent a semi-permeable barrier wildlife species such as grizzly bear. It is important to note that there is uncertainty in the grizzly bear population trend in the Elk Valley and factors that may most contribute to grizzly bear population stability; however, the Project is unlikely to contribute to limiting the ability of grizzly bear to recover from past declines and maintain a stable population in the Terrestrial LSA. Similarly, based on the characterization of the residual effects for wildlife VCs, the Project is not likely to reduce the ability of wildlife VCs to maintain stable populations in the Terrestrial LSA or Terrestrial RSA. As such, changes to population dynamics at a landscape level are not expected to occur as a result of the Project.

#### B.5.3.10 Genetic Diversity

Changes to genetic diversity can arise through isolation or loss of populations. The Project is predicted to increase habitat fragmentation and result in direct habitat loss in the Terrestrial LSA and Fish and Fish Habitat LSA; however, it is not predicted to result in barriers to movement for carnivore or ungulate species. The Project effects on species at risk such as whitebark pine have been determined to not be significant; as such, the Project is not expected to change regional genetic diversity.

##### B.5.3.10.1 Landscapes and Ecosystems

The federally-listed whitebark pine may be impacted by the Project through mortality and/or loss of habitat and changes in rates of germination, growth, and reproduction. Approximately 43% (591 ha) of potential whitebark pine habitat in the Landscapes and Ecosystems LSA may be affected by the Project. Consequently, the population would be subjected to a predicted net loss of 20% due to Project activities, with the remainder due to naturally-occurring disease or mortality. The removal habitat for whitebark pine increases survival pressure due to white pine blister rust (estimated infection rate of 52% in the region). However, despite these conditions no significant adverse residual or cumulative effects are predicted on vegetation species at risk as a result of the Project, as early research in restoration of whitebark pine has suggested there is potential for favorable restoration outcomes. The use of white pine blister rust resistant plants in restoration is anticipated to further improve the resilience of whitebark pine well beyond the closure of the Project. Regardless of the time required, the residual effect is considered reversible on a long-term scale and therefore, is considered to be not significant. Therefore the Project should not have a significant effect on the genetic diversity of whitebark pine.

#### B.5.3.10.2 Wildlife and Wildlife Habitat

Habitat fragmentation in the landscape is one of the greatest contributors of gene flow interruption interrupting genetic diversity. Currently within the Elk Valley, the associated effects of the Highway 3 corridor have resulted in a loss of gene flow between grizzly bear and wolverine populations due to direct mortality and the disconnection of previously connected habitat (Apps et al., 2007; Proctor et al., 2012; 2015; Mowat et al., 2020b). Major roads and other anthropogenic disturbances contribute to habitat fragmentation and result in a loss of connectivity between habitats and populations.

There will be significant residual effects of instream habitat loss due to mine design and development on the fish population in West Alexander Creek. In particular, there are a small number (i.e., 7) of resident Westslope Cutthroat Trout in West Alexander Creek which will be relocated prior to construction and infill of West Alexander Creek. As the resident population was previously not isolated by barriers to fish passage, and will be relocated downstream during fish catch and release (i.e., fish salvage) activities, it is anticipated that there will be no interruption to gene flow and genetic diversity within the population.

Although not a significant effect, the Project is anticipated to result in reduced habitat availability for wildlife. Through habitat loss and degradation, potential interruptions to gene flow may be associated with disruptions to movement and increased mortality risk. Measures that will contribute to connectivity of wildlife and wildlife habitat will include monitoring of wildlife underpasses to support connectivity between populations of carnivores and ungulates. In addition, the movement and foraging needs of wildlife will be supported through the Ecological Restoration Plan through the creation of high and low elevation forests, grasslands, whitebark pine dominated forests, sparsely vegetated talus, riparian habitat and wetlands. The Project will monitor wildlife underpasses to ensure connectivity between populations of carnivores and ungulates.

### B.5.4 Management of Potential Effects

NWP will use a robust Environmental Management System (EMS) to implement management plans and track compliance with regulations and permit requirements while continuously improving environmental protection measures and environmental performance. Appropriate mitigation measures to avoid, minimize, restore, and compensate and offset Project-related effects on VCs and the related effects on the biophysical factors that may be impacted as a result of effects to VCs are detailed in the Application/EIS and relevant VC chapters. Technically and economically feasible mitigation measures were based on BMPs, guidance documents, mitigation applied to similar projects and effects, and professional judgment. Mitigation was selected using the approach to the mitigation hierarchy outlined by the *Environmental Mitigation Policy for B.C.* (Ministry of Environment, 2014a) and the related *Procedures for Mitigation Impacts on Environmental Values* (Environmental Mitigation Procedures; Ministry of Environment, 2014b).

The management and monitoring plans that will be used to manage and mitigate potential effects to the biophysical factors that support ecosystem function include:

- Air Quality and Greenhouse Gas Management Plan;
- Ecological Restoration Plan;
- Erosion and Sediment Control Plan;
- Fish and Fish Habitat Management Plan;
- Landform Design and Reclamation Plan;
- Noise and Vibration Management Plan;
- Site Water Management Plan;
- Soil Management Plan;
- Spill Prevention, Control, and Countermeasures Plan;
- Vegetation and Ecosystems Management and Monitoring Plan;
- Waste Management Plan;
- Wildlife Management and Monitoring Plan;
- Access Management Plan;
- Mine Emergency Response Plan;
- Health and Safety Management Plan; and the
- Traffic Control Plan.

The above-listed plans will be refined through the environmental assessment process and completed and implemented prior to beginning Construction and Pre-Production activities. Detailed mitigation measures specific to each Project VC are provided in the Application/EIS VC chapters and are summarized in Chapter 33. Key mitigation measures identified in the relevant VC assessment chapters that will be used to reduce impacts to biophysical factors that support ecosystem function include but are not limited to:

- Implementation of the Ecological Restoration Plan and the Landform Design and Reclamation Plan to create and sustain healthy and biodiverse ecosystems following mine closure;
- Fish and Fish Habitat Management Plan and the related Conceptual Fish Habitat Offsetting Plan to improve and increase fish habitat focusing on Westslope Cutthroat Trout;
- Limit the mine disturbance footprint through Project design and progressive reclamation, including soil replacement and revegetation;
- Implement design standards for water management infrastructure and controlling outflows from water management facilities to maintain streamflow conditions in the receiving watercourses to the extent possible, particularly during low flow conditions;
- Decommissioning and reclaiming water management facilities to restore natural streamflow conditions in the receiving watercourses to the extent possible;
- Limit dust generation and emissions through the application of standard industry practices and emissions control measures;
- Limit erosion and contain sediment through the application of standard industry practices;
- Minimize disturbance of old growth and mature forest ecosystems by minimizing disturbance and cleared areas and where possible, delay construction of mine components until ready to mine;
- Perform regular road maintenance and restrict traffic in areas infested with invasive plants;

- Constructed underpasses will be created by elevating the conveyor to at least 2.4 m above ground (or higher where terrain can be used to create more clearance) at intervals of two per 1,000 m;
- Use directed/focused lighting, where possible, rather than broad area lighting to minimize sensory disturbance;
- Create gaps in snowbanks along access roads to allow for unimpeded ungulate passage across roads at regular intervals;
- Minimize potential Project effects on movement corridors (e.g., through Grave Creek Canyon) through use of signage along Project roads to warn vehicle operators of the potential to encounter wildlife;
- Avalanche control areas will be visually searched for wildlife prior to avalanche control activities along the access road; avalanche control activities will not be conducted when ungulates are present in potential slide areas;
- Minimizing disturbance and encroachment into natural vegetation, to the extent feasible, by clearing and grubbing only what is required for Construction and Pre-Production activities and progressive development of pits and Mine Rock Storage Facility; and
- All vegetation clearing will be conducted outside the general bird nesting period (mid-April to mid-August) in each year.

#### B.5.4.1 Adaptive Management

NWP is committed to operating the Project in a safe and environmentally responsible manner. The management strategies and mitigation measures outlined are anchored in an adaptive management philosophy. As part of continual improvement, the management plans described herein will be updated regularly to account for new and amended legislation, evolving industry standards, concerns from public stakeholders and Indigenous Communities, changes to the Project's design and/or schedule, or changes to mitigation measures based on monitoring results. Through adaptive management, rigorous management plans have been developed early for the Project, based on the best available information, and prior to detailed Project engineering and construction. After the completion of detailed engineering design, management plans will be adjusted, as needed, and monitoring will be implemented to determine whether the actions identified within the management plans are functioning as intended.

The mitigation measures to be implemented for the Project are based on BMPs and are expected to prevent or minimize adverse effects to human health and the receiving environment. Monitoring programs have been designed to provide early warning of environmental changes that may be of future concern. Through these early warnings, additional mitigation measures will be implemented, and the appropriate management plans and mitigation strategies modified. Adaptive management will accompany effectiveness monitoring as part of the follow-up program for each VC, as adjusting management actions based on the lessons learned from effectiveness monitoring will increase the likelihood of achieving mitigation commitments (Ministry of Environment, 2014b). If any unforeseen adverse effects are identified, intervention measures will be taken as soon as practicable to correct these effects and prevent them from occurring in the future.

Specific monitoring details are provided in each environmental management plan in Chapter 33 of the Application/EIS. As part of the adaptive management framework, the monitoring provisions generally include the following:

- Measuring the condition of the VC using selected environmental indicators;
- Setting performance criteria, standards, and thresholds, including alert and action levels; and
- Measures for evaluating root causes and the extent of effects to facilitate selection of appropriate actions.

For the VC being monitored, should the indicator or monitored parameter approach a predefined threshold, this would trigger an adaptive management response, which may include:

- Increasing the frequency of monitoring;
- Conducting studies to identify root causes; and
- Undertaking specific action(s) or mitigation measure(s) to address the concerns.

## B.5.5 Cumulative Effects

Cumulative effects are the result of Project residual effects interacting with the effects of other past, present, or future (certain, reasonably foreseeable, or hypothetical) projects and activities to produce a combined effect. An assessment of cumulative effects was completed for Project VCs, where relevant, and the results are presented in each VC assessment chapter in the Application/EIS. Potential cumulative effects were assessed for VCs that had an identified residual effect resulting from the Project and in those instances, the significance of residual cumulative effects was determined. Several past, present, and reasonably foreseeable projects or activities are expected to interact with the Project VCs, which may result in a potential for adverse cumulative effects on biophysical factors that support ecosystem function. Where several effects were evaluated in a particular VC, or where the screening of cumulative effects identified that a detailed evaluation of cumulative effects was required, temporal cases were defined, where appropriate, to assist in the assessment of cumulative effects. Temporal cases used in the assessment of cumulative effects included the Base Case, Project Case, and Future Case. The comparison of the Project Case with the Future Case allowed the Project contribution to cumulative effects of all past, present, and reasonably foreseeable future projects and/or activities to be determined.

Predicted residual cumulative effects of Project VCs that may influence biophysical factors that support ecosystem function at a regional scale include:

- Landscapes and Ecosystems:
  - Avalanche Chutes - 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. The Project is considered to have a disproportionately higher potential effect on avalanche chute ecosystems in the regional area in comparison to other reasonably foreseeable future developments. 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.
  - Grassland Ecosystems - 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.

- Old Growth and Mature Forests - 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. 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.
- Riparian Habitat - 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. As such, the Project does not have a disproportionately higher potential effect on riparian habitat in comparison to other developments in the Future Case.
- Wetland Ecosystems - 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. 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.

- Wildlife and Wildlife Habitat:
- Many present and reasonably foreseeable future projects and activities in the regional area have created impermeable barriers (e.g., pits and dumps at mines) or semi-permeable barriers (e.g., roads, and other linear features) for wildlife. While each of the existing and reasonably foreseeable future projects and activities considered in the Project cumulative effects assessment may block movements to varying degrees, they are geographically separated from the Crown Mountain Coking Coal Project such that additive barriers with the Project are limited.
- The effect of the Project on increased risk of wildlife mortality may combine with those of other reasonably foreseeable future projects and activities to produce a cumulative increase in mortality risk. The main pathways are from increased vehicle traffic resulting in increased wildlife-vehicle collisions and increased hunter access. Based on the characterization of the residual wildlife cumulative effects and regional wildlife population levels, the Project in combination with reasonably foreseeable future projects and activities is not expected to limit the ability of wildlife to persist and maintain self-sustaining populations in the Terrestrial RSA.

- Groundwater Quantity:
- Reductions of groundwater quantity resulting from the Project are predicted to remain within the range of normal variation, within typical estimate error and will be geographically confined to the LSA. No overlap or regional effects with other past, present, or reasonably foreseeable projects or activities is anticipated due to the geographical limits of the effects.

- Surface Water Quantity:

- Currently operating and proposed projects/activities (e.g., coking coal mines and forestry) are associated with the potential to contribute adverse cumulative effects on surface water quantity. As many of these projects/activities are located within the region of the Elk Valley, there is potential for cumulative effects to occur at the confluence of the Elk River and Michel Creek. The model prepared for the region includes the cumulative interactions with effects from ongoing mining operations, forestry activities, and hydroelectric and reservoirs dams in the Elk Valley. Results of the model indicate that the predicted change in surface water quantity for the Project Case is negligible to non-detectable (i.e., less than 1% compared to baseline), when considering mean annual and mean monthly flows during all Project phases at a regional scale. A qualitative assessment was not possible for reasonably foreseeable future projects in the region due to a lack of adequate information. It is expected, however, that any proposed future mining operation would implement an appropriate mitigation strategy for water management.

Residual effects on terrain were not identified during the Project VC effects assessment and as such, a cumulative effects assessment completed for terrain. No significant adverse residual cumulative effects resulting from the Project were identified through the VC cumulative effects assessments. Although other reasonably foreseeable future developments are anticipated to be subject to similar requirements for the mitigation of potential effects as those planned for the Project, it is unlikely that all interacting developments will be able to completely avoid or mitigate effects.

### B.5.6 Summary of Predicted Changes to Ecosystem Function

NWP proposes to develop and operate the Crown Mountain Coking Coal Project (the Project), an open pit steelmaking coal mine located in the Elk Valley coal field of the East Kootenay Region of B.C. The Project resource is a relatively small shallow coal deposit that outcrops in the eastern portion of the Elk Valley adjacent to the Alexander Creek Syncline which is the major geological feature of the Elk Valley coalfields. The Elk Valley region continues to be an important part of the traditional territories of local Indigenous groups. It is acknowledged that the ceremonial, traditional and spiritual practices of local Indigenous communities are tied to the environmental and ecological attributes of their lands which have provided sustenance since time immemorial.

The Project will affect biophysical factors that support ecosystem function as a result of the residual effects to Project VCs. The direct losses and/or indirect effects of the Project on VCs may contribute to impacts on biophysical factors at a landscape, watershed, and ecosystem scale. In particular, predicted changes to Project VCs groups that may result in changes to key biophysical factors that support ecosystem function, include:

- Habitats Supporting Ecosystem Function may be impacted by residual effects on landscapes and ecosystems VCs and wildlife and wildlife habitat VCs;
- Habitat Patches may be impacted by residual effects on landscapes and ecosystems VCs and wildlife and wildlife habitat VCs;
- Natural Disturbance Regime may be impacted by residual effects on landscape and ecosystems VCs;
- Structural Complexity may be impacted by residual effects on terrain and landscape and ecosystems VCs;

- Hydrologic Patterns may be affected by residual effects on terrain and groundwater and surface water quantity;
- Nutrient Cycling may be influenced by residual effects on surface water quality and the landscape and ecosystems VCs;
- Purification Services may be impacted by residual effects on landscapes and ecosystems VCs, air quality, and wildlife and aquatic health;
- Biotic Interactions may be impacted by residuals effects on landscapes and ecosystems VCs, wildlife and aquatic health, wildlife and wildlife habitat VCs, fish and fish habitat VCs, and whitebark pine;
- Population Dynamics may be impacted by residual effects on landscapes and ecosystems VCs, wildlife and wildlife habitat VCs, fish and fish habitat VCs, and whitebark pine; and
- Genetic Diversity may be impacted by landscapes and ecosystems VCs, wildlife and wildlife habitat VCs, and fish and fish habitat VCs.

Although the Project may have impacts on VCs that interact with biophysical factors at a landscape, watershed, and ecosystems level, the Project is not expected to result in significant adverse effects on biophysical factors that support ecosystem function. Through the implementation of rigorous mitigation and management plans based on the best available information and adaptive management procedures applied over the course of the Project, the Project will reduce potential adverse effects on the biophysical factors. The Project footprint is contained within a relatively small geographic extent and where possible, uses existing infrastructure (e.g., access roads) to reduce disturbance at a landscape and watershed level.

Progressive reclamation over the course of the Project will allow for landscapes and ecosystems to establish as soon as possible in disturbed areas and for primary succession to re-establish the ecological processes found in the local undisturbed ecosystems. Loss of landscapes and ecosystems, and subsequently wildlife habitat, will have a continuous adverse effect until progressive reclamation begins in Year 10 of Operations. With progressive reclamation between Years 10 and 15 and continued reclamation in the Reclamation and Closure phase, the effect of habitat loss will begin to decline. The Ecological Restoration Plan will restore approximately 750 ha within the Project development footprint and will create a variety of ecosystems in the local area including high and low elevation forests, grasslands, whitebark pine dominated forests, sparsely vegetated talus, riparian habitat and wetland ecosystems. Enhancement activities through progressive reclamation include the revegetation of forested areas within Project footprint to minimize the temporary loss of carbon sinks.

NWP has committed to carefully monitor the Project performance through follow-up measures, management actions, and collaborations with other parties throughout the Project life, and to adapt to changing conditions as negative changes occur to minimize the extent of those adverse effects. NWP is also committed to creating and sustaining relationships and ongoing dialogue with regulators, communities, and stakeholders to support the environmental, social, and economic sustainability of the Project. Through the implementation of an EMS and Project-specific mitigation measures and policies and procedures, NWP anticipates the Project will create economic, social, and environmental benefits for local communities, the Elk Valley, the Province of B.C., and Canada.

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