15. TERRESTRIAL ECOLOGY EFFECTS ASSESSMENT

15.1 INTRODUCTION

This chapter presents the baseline conditions, effects scoping process, and assessment of potential effects on terrestrial ecology and wetlands as a result of the proposed Harper Creek Project (the Project). This chapter follows the effects assessment methodology described in Chapter 8 of this Application for an Environmental Assessment Certificate / Environmental Impact Statement (Application/EIS). The assessment is based on baseline data collected for the Project, which are presented in Appendix 15-A. Terrestrial ecology and wetlands is a subject area under which several valued components (VCs) for the Project are grouped (collectively termed vegetation). The rationale for the selection of VCs is presented in Section 15.3.

Potential effects of the Project on wildlife and wildlife habitat are discussed in Chapter 16; the potential effects of the Project on the current use of lands and resources for traditional purposes is presented in Chapter 22.

15.2 REGULATORY AND POLICY FRAMEWORK

This section provides an overview of the relevant regulatory framework and requirements for potential Project-related effects to vegetation. Federal and provincial legislation and other guidelines or planning documents that relate to the EIS are detailed below.

15.2.1 *Mines Act* (1996a)

The British Columbia Ministry of Energy and Mines (BC MEM) requires that Terrestrial Ecosystem Mapping (TEM) of the proposed mine site area be completed for all Mines Act permit applications. The BC MEM requires characterization of baseline metal concentrations in soil and plant tissues for Mines Act permit applications. This information is used to assess changes over time and to guide reclamation planning (BC MEMPR 2008).

15.2.2 *Species at Risk Act* (2002b)

The *Species at Risk Act* (SARA; 2002b) was proclaimed in June 2003 as part of a three-part strategy for the protection of wildlife species at risk in Canada. The purpose of SARA is "to prevent Canadian indigenous species, subspecies, and distinct populations from being extirpated or extinct, to provide for the recovery of endangered or threatened species, and encourage the management of other species to prevent them from becoming at risk"(2002b).

SARA prohibits the killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading of individuals (or its parts or derivatives) of endangered, threatened and extirpated species listed in Schedule 1 of the Act. It also prohibits the damage or destruction of the residence of one or more individuals of a listed endangered or threatened species, or a listed species

if a recovery strategy has recommended its reintroduction into the wild into Canada. SARA applies to:

- all endangered, threatened, and extirpated species listed on Schedule 1 when located on federal lands and territories;
- all endangered, threatened, and extirpated species listed on Schedule 1 that are also protected by the *Migratory Bird Convention Act* (MBCA; 1994) when located on any land (federal, provincial, or private); and
- all endangered, threatened, and extirpated aquatic species (as defined by SARA) listed on Schedule 1 when located on any land (federal, provincial, or private).

SARA also applies to unlisted species on federal lands when those species have been legally classified as threatened or endangered by a provincial or territorial minister. In addition, SARA has the option to be applied to non-MBCA, non-aquatic Schedule 1 species on provincial or private land if appealed for under sub-section 34 of the Act.

For those species listed as special concern under SARA, the federal government is required to prepare a management plan for that species and its habitat, including identifying measures for the conservation of the species.

15.2.3 BC *Wildlife Act* (1996c)

15.2.3.1 Provincial Red and Blue Lists

Species and ecological communities at risk (ECAR) in British Columbia (BC) are placed on provincial lists according to their degree of endangerment. The Red List includes "ecological communities, and indigenous species and subspecies that are extirpated, endangered or threatened in British Columbia" (BC MOE 2011). The Blue List includes "ecological communities, and indigenous species and subspecies of special concern (formerly vulnerable) in British Columbia" (BC MOE 2011). Taxa that are not considered at risk are placed on the Yellow List. Species may be transferred from one list to another list either because of an actual change in their ecological circumstance (change in risk), or because new data becomes available on their range, taxonomy, population trend, or numbers to justify a change in status. The latter situation is especially relevant for poorly understood taxa for which even basic life history information may be sparse.

15.2.4 *Forest and Range Practices Act* (2002a)

The *Forest and Range Practices Act* (FRPA; 2002a) regulates the activities of forest and range licensees in BC, including requirements for planning, road building, timber harvest, reforestation, and grazing. It also provides for the management of wildlife alongside forest and range activities. Management includes the designation of Ungulate Winter Ranges (UWR) for important ungulate habitat and Wildlife Habitat Areas (WHAs) for Identified Wildlife. Identified Wildlife species, as designated under the FRPA, are species endangered or vulnerable in BC and may be affected by forest or range management on Crown land. One strategy for managing Identified Wildlife is the

use of designated areas, known as WHAs that are managed for particular Identified Wildlife species or plant communities and generally contain important habitat elements.

15.2.5 Federal Policy on Wetland Conservation

In 1991, the Government of Canada adopted the Federal Policy on Wetland Conservation (Government of Canada 1991). The objective of this policy is to "promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future." To achieve this objective the government has identified goals regarding maintenance of wetland function (including no net loss of wetland functions on all federal lands and waters), enhancement and rehabilitation of wetlands, recognition of wetland function and sustainable wetland management in planning processes, and securement of important wetlands. Strategies to achieve these goals include:

- developing public awareness and understanding of wetland resources;
- wetland management on federal lands and waters and in other federal programs that can act as an example to other wetland management programs;
- promoting wetland conservation in federal protected areas;
- enhancing cooperation with provinces, territories, and non-government agencies to advance wetland conservation;
- conserving wetlands of significance to Canadians;
- ensuring a sound scientific basis for wetland conservation policy; and
- promoting international actions.

15.2.6 BC *Weed Control Act* (1996b)

The purpose of the BC *Weed Control Act* (1996b) is to protect natural resources and industry from the negative impact of foreign weeds.

The Act states: "Every occupier shall control, in accordance with the regulations, noxious weeds growing or located on land and premises, and on any other property located on land and premises, occupied by him." This means that private landowners, private companies, utility companies, regional districts and municipalities, and provincial government agencies or anyone in physical possession of land all have a responsibility to manage weeds in the province.

The BC *Weed Control Act* (1996b) currently designates 48 plant species as noxious weeds. Currently, 21 weeds are listed as noxious weeds within all regions of the province. A further 27 are classified as noxious within the boundaries of the Thompson-Nicola Regional District. All of these species are non-native plants that create problems in agriculture and/or natural habitats.

15.2.7 Kamloops Land and Resource Management Plan

The Kamloops Land and Resource Management Plan (LRMP; Kamloops Interagency Management Committee 1995) is a sub-regional land use plan covering 2.2 million ha of south-central BC. The

three main sections of this LRMP include Six Resource Management Zones, Implementation, and Monitoring and Amendment.

15.2.8 BC Conservation Data Centre

The BC Conservation Data Centre (BC CDC 2014a) systematically collects and disseminates information on plants, animals and ecosystems (ecological communities) at risk in BC.

This information is compiled and maintained in a computerized database which provides a centralized and scientific source of information on the status, locations, and level of protection of these organisms and ecosystems.

15.2.9 *Canadian Environmental Protection Act, 1999* (1999)

The *Canadian Environmental Protection Act, 1999* (CEPA; 1999) is an important part of Canada's federal environmental legislation aimed at preventing pollution and protecting the environment and human health. The goal of CEPA is to contribute to sustainable development—development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

15.2.10 *Environmental Management Act* (2003)

Pulling together the provisions of the previous Waste Management and Environment Management Acts into a single statute, the *Environmental Management Act* (2003) prohibits the introduction of deleterious substances into the environment in any manner or quantity that may cause pollution to the environment as defined in the act.

15.2.11 Metal Mining Effluent Regulations (MMER; SOR/2002-222)

Sets out a list of substances defined as "deleterious" and prescribes thresholds and procedures whereby an owner or operator of a mine may deposit such substances.

15.3 SCOPING THE EFFECTS ASSESSMENT

15.3.1 Valued Components

The BC Environmental Assessment Office (BC EAO) define VCs as components "that are considered important by the proponent, public, First Nations, scientists, and government agencies involved in the assessment process" (BC EAO 2013a). To be included in the Application/EIS, there must be a perceived likelihood the VC will be affected by the proposed Project. VCs proposed for assessment were identified in the Application Information Requirements (AIR; BC EAO 2011) and in the Canadian Environmental Assessment Agency (CEA Agency; 2011) Background Information document.

15.3.1.1 Consultation Feedback on Proposed Valued Components

A preliminary list of proposed VCs was drafted early in project planning based on the expected physical works and activities of the project; type of project being proposed; local area and regions where the proposed project would be located; and consultation with federal, provincial, and local government agencies. A summary of how scoping feedback was incorporated into the selection of assessment subject areas and VCs is summarized below in Table 15.3-1.

VCs are aspects of the environment considered important by the proponent, the public, First Nations, and government agencies involved in the environmental assessment (EA) process. Importance may be determined on the basis of First Nations interests, scientific and/or regulatory concern, biodiversity concern, and sensitivity to proposed project effects.

Table 15.3-1 Consultation Feedback on Proposed Valued Component(s)

	Feedback by*				
Subject Area	AG	G	P/S	Issues Raised	Proponent Response
Rare plants		✓		Disturbance or loss of rare plant populations	Rare plants included as VC
Rare ecological communities		✓		Loss of Red- and Blue-listed ECAR	ECAR included as VC
Sensitive ecological communities	✓	✓	✓	Disturbance or loss of wetlands, old-growth forests, and rock outcrops	Wetlands, old-growth forests, and rock outcrops included as VCs
Traditional-use plants	✓			Loss of availability and access to traditional-use plants identified by Simpcw First Nations	Traditional-use plants reviewed as candidate VCs

**AG = Aboriginal Group; G = Government; P/S = Public/Stakeholder.*

15.3.1.2 Selecting Valued Components

Six potential VCs were identified during Project consultations. Summaries of each of these VCs are described below, and their potential interaction with Project components is shown in Table 15.3-2.

Rare Plants

Rare plants for the Project were defined as species listed on Schedule 1 of SARA as amended (2002b), species assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2012), species on the BC Ministry of Environment's provincial Red- or Blue-lists (BC CDC 2012b). Other species that were not previously identified or potentially new to science and hence unlisted in BC were also noted. Due to limited known occurrences, sensitivity to effects, and concern from provincial and federal governments, rare plants have been identified as a potential VC for the Project.

Table 15.3-2. Identification and Rationale for Selection of Valued Components

Category	Rare Plants	Ecological Communities at Risk	Wetlands	Old-growth Forests	Rock Outcrop	Traditional-use Plants
Construction						
Concrete production						
Dangerous goods and hazardous materials	x	x	x			x
Environmental management and monitoring	x	x	x	x		x
Equipment	x	x				x
Explosives	x					x
Fuel supply, storage and distribution	x					x
Open pit	x	x	x			x
Potable water supply						
Power supply	x	x	x	x		x
Processing	x					x
Procurement and labour						
Project Site development	x	x	x	x		x
Rail load-out facility						x
Roads	x	x	x			x
Stockpiles	x	x	x	x		x
Tailings management	x					x
Temporary construction camp	x	x				x
Traffic	x	x				x
Waste disposal	x					x
Water management	x	x				x
Operations 1						
Concentrate transport	x					x
Dangerous goods and hazardous materials	x	x	x	x		x
Environmental management and monitoring	x					x
Equipment	x	x				x
Fuel supply, storage and distribution						
Mining	x	x	x			x
Ore processing	x	x	x			x
Potable water supply	x					X
Power supply	x					x

(continued)

Table 15.3-2. Identification and Rationale for Selection of Valued Components (completed)

Category	Rare Plants	Ecological Communities at Risk	Wetlands	Old-growth Forests	Rock Outcrop	Traditional-use Plants
Operations 1 ***(cont'd)***						
Processing						
Procurement and labour						
Rail load-out facility	x					x
Reclamation and decommissioning	x	x	x	x		x
Stockpiles	x					x
Tailings management	x					x
Tailings management	x					x
Traffic	x	x				x
Waste disposal	x	x				x
Water management	x	x	x	x		x
Operations 2						
Processing	x	x	x			x
Reclamation and decommissioning						x
Tailings management						x
Water management	x	x	x	x		x
Closure						
Environmental management and monitoring	x		x			x
Open pit						
Procurement and labour						
Reclamation and decommissioning	x	x	x			x
Stockpiles						x
Tailings management						x
Waste disposal						x
Post-Closure						
Environmental management and monitoring	x	x	x			x
Open pit						
Procurement and labour						
Stockpiles						x
Tailings management	x					x

Note: a column is marked with an X when it has been determined that the Project component or activity could potentially interact with the VC.

A list was prepared of rare plants either already known to occur in the Project vicinity (Kamloops and Headwaters Forest Districts) or with a global range likely to include the Project vicinity (Hitchcock et al. 1955; Lawton 1971; Cronquist, Holmgren, Holmgren, Holmgren, et al. 1977; Moss and Packer 1983; Flora of North America Editorial Committee 1993; Goward, McCune, and Meidinger 1994; Cody 1996; Douglas, Meidinger, and Pojar 1998; Goward 1999; Doyle and Stotler 2006; Spribille 2006; Flora of North America Editorial Committee 2007; Laine 2009; C. Björk and Goward 2011; C. R. Björk 2011; NatureServe 2011; BC CDC 2012a, 2012b, 2012c; Klinkenberg 2012; BC CDC 2014b). The final list of rare plants potentially present in the Project area is presented in Appendix 15-B. It includes 36 vascular plants, 15 mosses, and 40 lichens.

Ecological Communities at Risk

Ecological communities are defined as "the assemblage of species that co-occur in defined areas at certain times and that have the potential to interact with each other" (McPeek and Miller 1996), (BC CDC 2004)). ECAR are ecological communities that are Red- or Blue-listed by the BC CDC (2014b). They are placed on the Red- or Blue-lists according to the degree of threat, trend in area of occupancy, number of protected and managed occurrences, intrinsic vulnerability, specificity of habitat requirements, and other considerations (BC CDC 2014b). Due to the provincial government concern for Red- and Blue-listed communities, ECAR have been identified as a potential VC for the Project.

A list was prepared of ECAR with the potential to occur in the Project vicinity. This list was developed by identifying the biogeoclimatic (BGC) variants within the local study area (LSA), and consulting BC CDC records of ECAR with the potential to occur in those BGC variants (BC CDC 2012c, 2012b, 2014b). Twelve potential ECAR were identified for the Project, including two Red-listed and 10 Blue-listed communities (Table 15.3-3).

Table 15.3-3. ECAR Potentially Occurring within the Project Area

Common Name	Scientific Name	BC List
Black spruce / buckbean / peat-mosses	*Picea mariana / Menyanthes trifoliata / Sphagnum spp.*	Blue
Buckbean - slender sedge	*Menyanthes trifoliata - Carex lasiocarpa*	Blue
Common cattail Marsh	*Typha latifolia Marsh*	Blue
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum spp.*	Blue
Mountain alder / red-osier dogwood / lady fern	*Alnus incana / Cornus stolonifera / Athyrium filix-femina*	Blue
Narrow-leaved cotton-grass - shore sedge	*Eriophorum angustifolium - Carex limosa*	Blue
Slender sedge / common hook-moss	*Carex lasiocarpa / Drepanocladus aduncus*	Blue
Swamp horsetail - beaked sedge	*Equisetum fluviatile - Carex utriculata*	Blue
Three-way sedge	*Dulichium arundinaceum Herbaceous Vegetation*	Red
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	Blue
Western hemlock / velvet-leaved blueberry – falsebox	*Tsuga heterophylla / Vaccinium myrtilloides - Paxistima myrsinites*	Red
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	Blue

Wetlands

Wetlands are defined as areas of land saturated by water, permanently or intermittently, for a long enough time that the excess water and subsequent anoxic conditions result in a change in the plants and wildlife inhabiting the area to those that are adapted to aquatic conditions (BC MOF 2000; The Wetland Stewardship Partnership 2010). Wetlands include five primary freshwater types: bogs and fens (both are peatlands), swamps, marshes, and shallow open waters such as sloughs and ponds (BC MOF 2000). Wetlands are vulnerable to changes in hydrological regime, pollutants, siltation, compaction, and the effects of invasive plant species (MacKenzie and Moran 2004; Cox and Cullington 2009). Loss of wetlands is a concern to both provincial and federal governments. Environment Canada has identified the goal of maintaining wetland functions and values through a policy of no net loss of wetland function on federal lands (Government of Canada 1991). Due to federal concern and inherent sensitivity to disturbance, wetlands were identified as a potential VC for the Project.

Old-growth Forests

Old-growth forests are climax ecosystems characterized by relatively tall, old trees, and structural diversity. Old-growth forests provide valuable habitat for plant and animal species that prefer large-diameter trees, multi-layered stands, high densities of snags, and other characteristics that require many years to develop. Losing these ecosystems can negatively impact the species that depend on them, including critical habitat for species at risk. Old-growth forests were identified as a concern to the provincial government and First Nations during Project consultations and identified as a potential VC for the Project.

Rock Outcrops

Rock outcrop ecosystems occur on areas of exposed rock and are characterized by shallow, poorly developed soil, high summer temperatures, drought, and sparse vegetation cover (Ware 1990). They are often limited in their distribution on the landscape. However, their rocky substrates have been shown to support high taxonomic richness, particularly for non-vascular plants (Vitt and Belland 1997; Sadler and Bradfield 2010), and provide specialized habitat for some wildlife species such as bats and snakes. They were identified within the AIR as a sensitive ecosystem of concern for the Project assessment and were scoped in as a potential VC for the Project.

Traditional-use Plants

A list of traditional-use plants was provided by First Nations for consideration as a potential VC for the project. The list of plants is included in Appendix 15-C.

15.3.1.3 Rationale for Exclusion of Potential Valued Components

During baseline studies, no rock outcrops were identified within the LSA. Two were located near the southeastern edge of the LSA. Based on this baseline data collected and our understanding of the Project, rock outcrops will have unmeasurable or no interactions with the Project and are excluded from the effects assessment.

The traditional use plants list was reviewed by a botanist. Species included in this list were either not expected to be impacted by the Project, common throughout the LSA, introduced species, or do not occur in the area. Based on the review of the list of traditional-use plants and an understanding of the Project, traditional-use plants will have an unmeasurable or negligible interaction with the Project. Traditional-use plants are excluded from the effects assessment. The Rationale for exclusion of each of these plants from the effects assessment is provided in Appendix 15-C.

15.3.1.4 Valued Components Selected for Assessment

The proposed VCs that were selected for assessment for the Project are summarized in Chapter 8, Effects Assessment Methodology, Table 8.4-3. The VCs selected for inclusion in the terrestrial and wetlands effects assessment are presented in Table 15.3-4. This list was presented to the EA Working Group for discussion on September 17, 2014. These are collectively referred to as vegetation VCs in this chapter.

Table 15.3-4. Valued Components Selected for Assessment

Assessment Category	Subject Area	Valued Components
Environment	Terrestrial environment	Rare plants
		Wetlands
		Old-growth forests
		ECAR

15.3.2 Defining Assessment Boundaries

Assessment boundaries define the maximum limit within which the effects assessment and supporting studies (e.g., predictive models) are conducted. Boundaries encompass where and when the Project is expected to interact with the VCs, any political, social, and economic constraints, and limitations in predicting or measuring changes. Boundaries relevant to vegetation VCs are described below.

15.3.2.1 Temporal Boundaries

Temporal boundaries, provided in Table 15.3-5, are the time periods considered in the assessment for various Project phases and activities. Temporal boundaries reflect those periods during which planned Project activities are reasonably expected to potentially affect a VC. Potential effects will be considered for each phase of the Project as described in Table 15.3-5.

15.3.2.2 Spatial Boundaries

Project Site Area

The Project Site is defined by a buffer of 500 m around the primary Project components. Project components include the open pit; the open pit haul road, primary crusher, and ore conveyor; mill plant site with ore processing facilities and intake/outtake pipelines; TMF; overburden, topsoil, PAG waste rock, and non-PAG waste rock stockpiles; and non-PAG and PAG low-grade ore

stockpiles (Figure 15.3-1). The disturbed area is projected to be 1977 ha, which is 56% of the Project Site area (3501 ha).

Table 15.3-5. Temporal Boundaries used in the Assessment for Vegetation Valued Components

Phase	Project Year	Length of Phase	Description of Activities
Construction	-2 and -1	2 years	Pre-construction and construction activities.
Operations 1	1 - 23	23 years	Active mining in the open pit from Year 1 through to Year 23.
Operations 2	24 - 28	5 years	Low-grade ore processing from the end of active mining through to the end of Year 28.
Closure	29 – 35	7 years	Active closure and reclamation activities while the open pit and TMF are filling.
Post-Closure	36 onwards	50 years	Steady-state, long-term closure condition following active closure, with ongoing monitoring.

Local Study Area

The LSA was identified as the primary area for baseline studies vegetation VCs for the Project—the majority of baseline studies took place within this boundary. The LSA encompassed all Project facilities and an area of 1,000 m on all sides of these facilities (Figure 15.3-1), for a total size of 11,084.5 ha. The Project Site is 32% of the LSA. The LSA includes areas beyond Project footprints to include areas where both direct and indirect Project-specific effects are most likely to occur for vegetation VCs. The LSA takes into consideration available information and professional opinion on zones of influence (i.e., area of reduced use or avoidance), and prescribed or recommended setbacks (Environment Canada 2009; Government of Alberta 2011; BC MOE 2012).

Regional Study Area

The regional study area (RSA) was used as the assessment area for cumulative effects within the Application/EIS. The RSA consisted of the Vavenby and Barriere Landscape Units (LUs), which encompassed the Project, the LSA, and a broader surrounding area where there is potential for interaction of the proposed Project with past, present, and future activities that might result in cumulative adverse effects on vegetation VCs (Figure 15.3-2). LUs are spatially identified areas of land and/or water used for long-term planning of resource management activities. LUs are important for designing strategies and objectives to maintain landscape level biodiversity and for managing other forest resources such as old-growth forest retention and timber harvesting. The RSA has a total size of 150,010 ha. The Project Site is 2.3% of the RSA. The RSA was also used to quantify and summarize regional data relevant to the assessment, and for the cumulative effects assessment.

No administrative or technical boundaries were applied to the terrestrial ecology effects assessment.

Figure 15.3-1

Terrestrial Ecology and Wetlands Effects Assessment Local Study Area

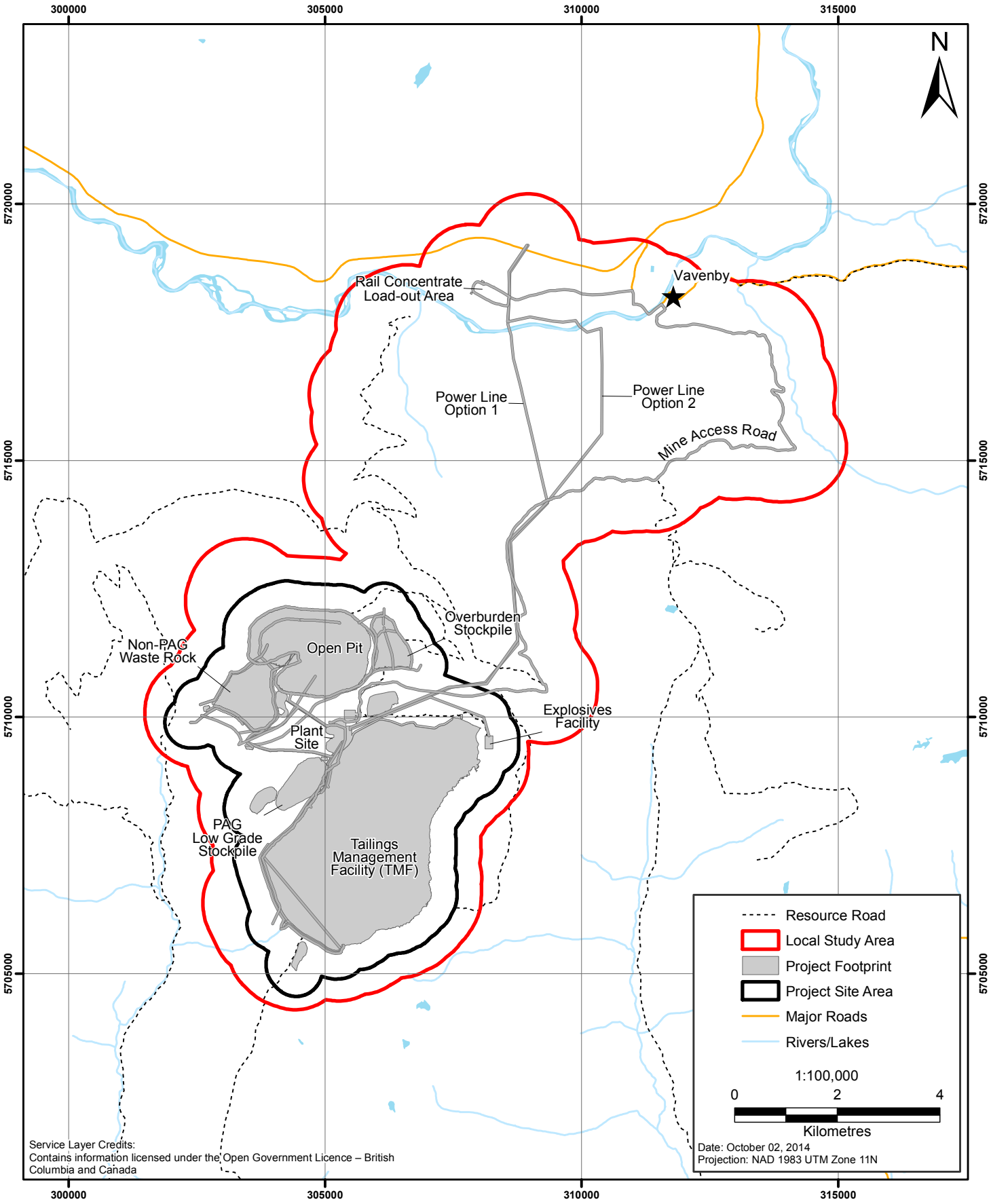
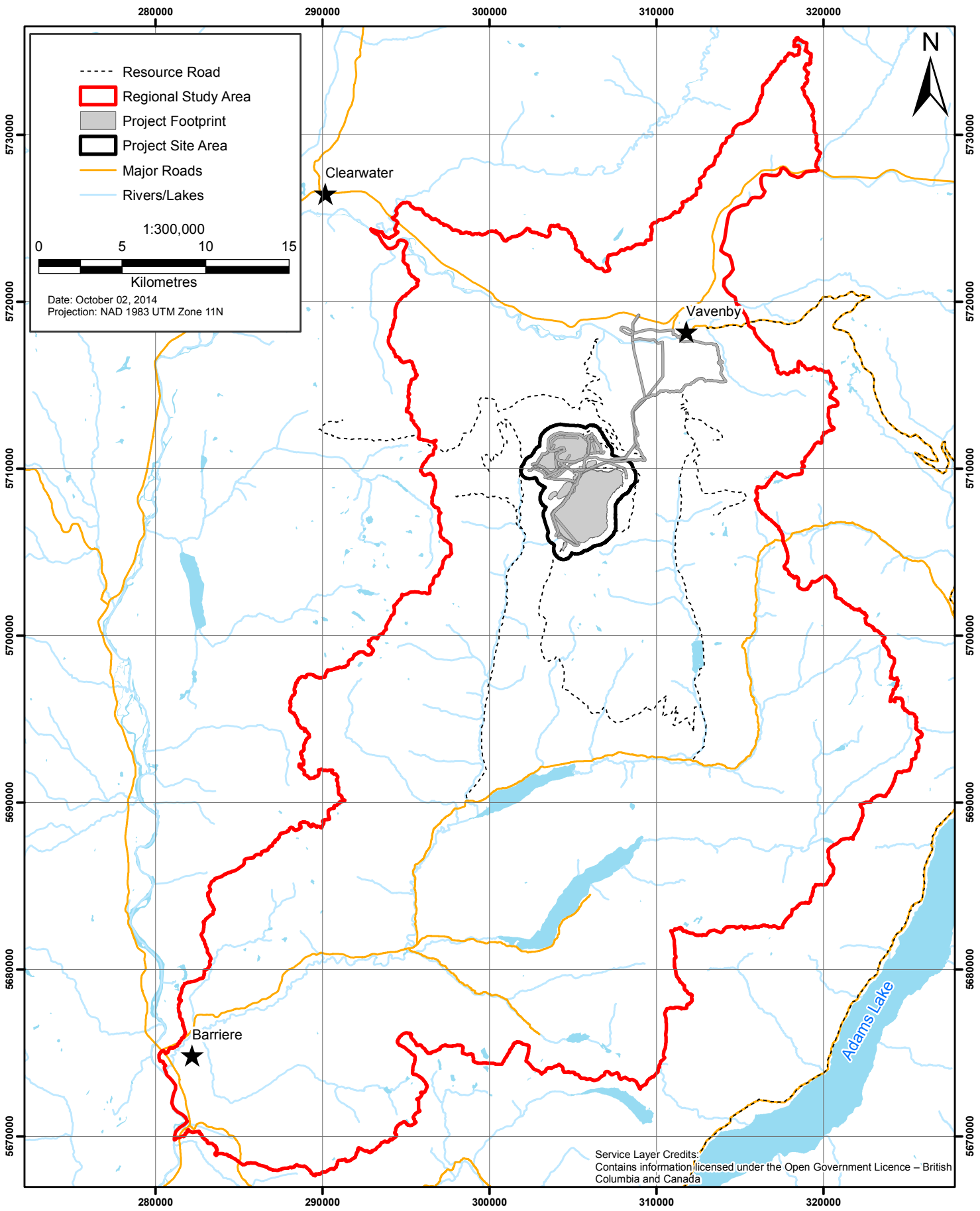


Figure 15.3-2

Vegetation Effects Assessment Regional Study Area



15.4 BASELINE CONDITIONS

15.4.1 Regional and Historical Setting

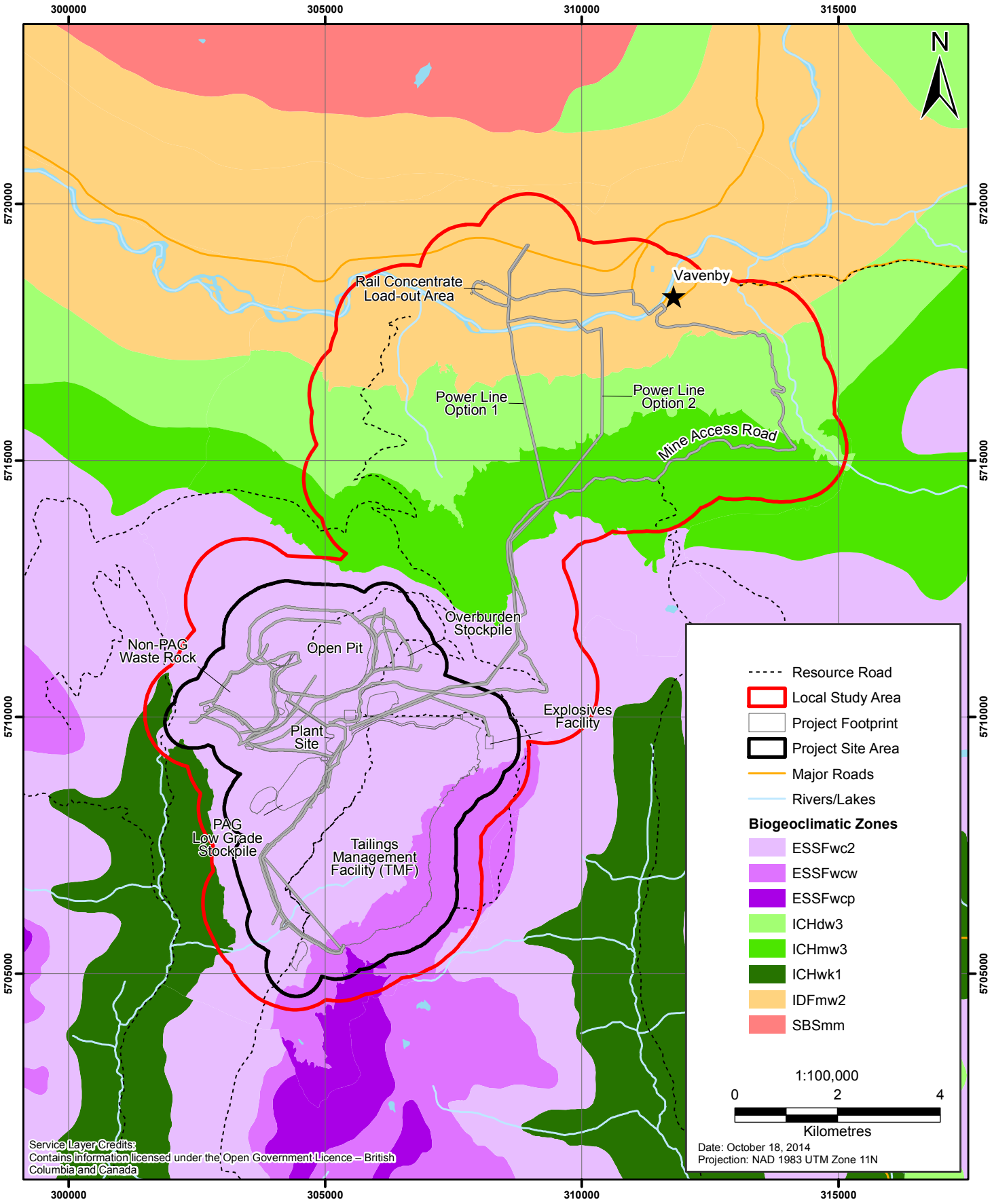
Vegetation communities or ecosystems are the product of a complex interaction of vegetation, animals, microorganisms, and the physical environment (climate, topographic relief, soil and geological material present, and the history of an area) (D. A. Lloyd et al. 1990). These factors lead to large-scale ecosystem groups, or BGC variants. The Project Site is composed of the following BGC variants (Figure 15.4-1): the Thompson Moist Warm Interior Douglas-Fir variant (IDFmw2), the North Thompson Dry Warm Interior Cedar – Hemlock variant (ICHdw3), the Thompson Moist Warm Interior Cedar – Hemlock variant (ICHmw3), the Wells Gray Wet Cool Interior Cedar – Hemlock variant (ICHwk1), the Northern Monashee Wet Cold Engelmann Spruce – Subalpine Fir variant (ESSFwc2), the Wet Cold Engelmann Spruce – Subalpine Fir Woodland subzone (ESSFwcw), and the Wet Cold Engelmann Spruce – Subalpine Fir Parkland subzone (ESSFwcp). The RSA is composed of 33% of ESSF, 45.4% ICH, and 17.3% IDF, and the LSA is composed of 29.3% ESSF, 21.9% ICH, and 10.9% IDF. Descriptions below have been summarized from Lloyd et al. (2005).

The IDFmw2 occurs from 375 m in the valley bottoms to 1,150 m elevation and is characterized by a warm, dry climatic regime with a relatively long growing season. Mid-summer soil moisture deficits are common, particularly on south aspects, receiving about 52 cm of precipitation annually, with snowpacks rarely exceeding 75 cm. Dominant tree species include Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). The understory is shrubby and dominated by falsebox (*Pachistima myrsinites*), Saskatoon (*Amelanchier alnifolia*), Oregon-grape (*Mahonia aquifolium*), birch-leaved spirea (*Spiraea betulifolia*), baldhip rose (*Rosa gymnocarpa*), and thimbleberry (*Rubus parviflorus*). The herb and moss layers are typically sparse.

The ICHdw3 occurs from 450 m in the valley bottoms to 1,200 m elevation and is the driest variant of the ICH. Summer soil moisture deficits occur frequently, receiving 50–60 cm of annual precipitation; snowpacks rarely exceed 75–100 cm. Forest cover is dominated by a mixture of broadleaf and conifer species including western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), lodgepole pine, Douglas-fir, paper birch, and trembling aspen, with western redcedar and western hemlock being the most common regeneration species that would dominate climax stands. The understory has a moderately well-developed shrub layer containing falsebox, birch-leaved spirea, black huckleberry (*Vaccinium membranaceum*), and thimbleberry, with a poorly developed herb layer. The moss layer is well developed and dominated by red-stemmed feathermoss (*Pleurozium schreberi*) and electrified cat's-tail moss (*Rhytidiadelphus triquetrus*).

The ICHmw3 occurs from 450 m in the valley bottoms to 1,600 m elevation and is moister than the ICHdw3. Prolonged summer droughts are uncommon, with an average annual precipitation of 60-80 cm, and winter snow accumulations of 100–200 cm. Western hemlock and western redcedar dominate late successional stands with hybrid Engelmann x white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*) occurring commonly on wetter sites subject to cold air drainage at upper elevations. Fire history coupled with human disturbance has led to the widespread development of successional stands dominated by Douglas-fir, lodgepole pine, and western white pine (*Pinus monticola*). The understory is dominated by mosses, with a sparse shrub layer containing falsebox and an equally sparse herb layer.

Figure 15.4-1
Biogeoclimatic Variants in the Local Study Area



The ICHwk1 occurs from 500 m in the valley bottoms to 1,500 m elevation and has a relatively long growing season due to warm summers and a relatively constant supply of moisture. An average annual precipitation of 80–120 cm combined with an average snowpack of 150–200 cm results in soils rarely experiencing a moisture deficit. Late succession stands of western hemlock and western redcedar dominate the landscape, with Douglas-fir, hybrid white spruce, and subalpine fir occurring in mixed successional stands. The understory has a poorly developed shrub layer, but an extensive herb layer dominated by oak fern (*Gymnocarpium dryopteris*), bunchberry (*Cornus canadensis*), queen's cup (*Clintonia uniflora*), one-leaved foamflower (*Tiarella trifoliata* var. *unifoliata*), rosy twisted stalk (*Streptopus lanceolatus*), five-leaved bramble (*Rubus pedatus*), and wild sarsaparilla (*Aralia nudicaulis*). Mosses are also well developed and include red-stemmed feathermoss, step moss (*Hylocomium splendens*), pipe cleaner moss (*Rhytidiopsis robusta*), and knight's plume (*Ptilium crista-castrensis*).

The ESSFwc2 occurs at higher elevations, 1,300 m to 1,800 m, and is characterized by a short growing season due to long, cold winters and short, cool summers. Growing season moisture deficits are rare, with an average annual precipitation of 100–150 cm, with maximum snow depths ranging from 200–300 cm. Climax stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir dominate the landscape, with white-flowered rhododendron (*Rhododendron albiflorum*) dominating the understory. The rich herb layer consists of oak fern, Sitka valerian (*Valeriana sitchensis*), five-leaved bramble, rosy twisted stalk, and one-leaved foamflower, with a patchy moss layer.

The ESSFwcw occurs at elevations of 1,600 m to 2,000 m. This variant is characterized by long, cold winters with a deep snowpack (300–400 cm), and short, cool summers. An average summer precipitation of 180–220 cm, combined with the late snowmelt and a very short frost-free period contribute to the short growing season. Most stands are dominated by subalpine fir, with a variably-developed shrub layer containing black huckleberry and white-flowered rhododendron. The herb layer is moderately well developed and includes Sitka valerian, mountain arnica (*Arnica latifolia*), wood-rush (*Luzula* spp.), and mountain hairgrass (*Vahlodea atropurpurea*). The moss layer is also well developed and is dominated by common leafy liverwort (*Barbilophozia lycopodioides*) and mountain leafy liverwort (*Barbilophozia floerkei*).

The ESSFwcp occurs at the highest elevations within the study area. Discontinuous forests of subalpine fir tree islands occur in this variant. Trees are stunted due to the very short growing season coupled with harsh environmental conditions. Alpine heaths of mountain-heathers (*Phyllodoce* spp.) and sparsely-vegetated areas with shallow soils are prevalent.

Extensive human development has occurred in the region relating to forest harvesting and recreational use. Within the RSA, 56,443 ha have been logged since the forest industry began operations in the area, according to the Vegetation Resource Inventory (VRI). This accounts for 37.6% of the RSA. Approximately half of the logging to date occurred prior to 1960. Consequently, the remaining forest is fragmented, which has been exacerbated by increasing road density and grazing. Most of the roads are actively used by forestry, recreational users (hunters, hikers, and snowmobilers), and travelers (driving between the towns of Vavenby and Barriere). The Dunn Peak Protected Area is a large wilderness area providing backcountry recreation opportunities. The addition of a boardwalk and other recent trail work has improved hiking conditions and increased use of the area. Snowshoeing and backcountry and alpine ski touring opportunities also exist on

Dunn Peak (BC Parks 2012). Both sheep and cattle graze within the RSA, with flocks and herds grazing on rangeland and alpine flower meadows from spring to fall.

15.4.2 Baseline Studies

The following section provides a summary of the baseline studies that were conducted for vegetation. The purpose of the baseline studies was to establish the presence and distribution of rare plants, and rare and sensitive ecosystems based on Terrestrial Ecosystem Mapping (TEM). See Appendix 15-A for a more detailed description of the baseline studies and accuracy assessment.

15.4.2.1 Rare Plants

Prior to baseline surveys a list was prepared of rare plants either already known to occur in the Project vicinity or with a global range that is likely to include the Project vicinity. The following sources were consulted:

- BC CDC records of known BC- and SARA-listed rare plant occurrences within the vicinity of the LSA (BC CDC 2012b, 2012a, 2014b);
- annotated checklist of the vascular flora of Wells Gray Park (C. Björk and Goward 2011);
- species distribution maps on the Electronic Atlas of the Flora of British Columbia website (Klinkenberg 2012);
- published vascular floras (Hitchcock et al. 1955; Cronquist, Holmgren, Holmgren, Reveal, et al. 1977; Moss and Packer 1983; Flora of North America Editorial Committee 1993; Cody 1996; Douglas, Meidinger, and Pojar 1998);
- moss and liverwort keys (Lawton 1971; Doyle and Stotler 2006; Flora of North America Editorial Committee 2007; Laine 2009);
- lichen keys (Goward, McCune, and Meidinger 1994; Goward 1999; Spribille 2006; C. R. Björk 2011);
- online databases (NatureServe 2011; BC CDC 2012b); and
- a list of plants provided by the First Nations (see Appendix 15-C).

The fieldwork for both years used the same general pedestrian survey methods, differing slightly in the types of transect walked and the specific data collected. All surveys were performed using the targeted-meander search pattern (Krichbaum 1998; Whiteaker et al. 1998).

15.4.2.2 Ecological Communities at Risk

A list was prepared of ECAR with the potential to occur in the Project vicinity. This list was developed by identifying the BGC variants within the LSA, and consulting BC CDC records of ECAR with the potential to occur in those BGC variants (BC CDC 2012b, 2012a, 2014b). Twelve potential ECAR were identified for the Project, including two Red-listed and 10 Blue-listed communities. No surveys were conducted prior to Project baseline studies that identify the locations of any ECAR in the LSA, nor does the BC CDC identify any known locations.

Sites with the potential to support ECAR within the LSA were identified using TEM. Terrestrial Ecosystem Mapping is a method of mapping that uses both terrain and vegetation characteristics to classify a landscape into map polygons. It has two components, bioterrain and ecosystems. Most ECAR can be related to a specific site series; the related site series has the potential to support the ECAR, though does not guarantee its presence.

Field studies were undertaken to confirm the accuracy of the ecosystem mapping and the presence of habitat features. Protocols for field truthing were based on the *Field Manual for Describing Ecosystems* (BC MELP and BC MOF 1998).

15.4.2.3 Wetlands

Wetlands within the LSA were identified using TEM. Terrestrial Ecosystem Mapping was conducted following methods described in Appendix 15-A. The Project TEM only extends to the limits of the LSA. To put the LSA wetlands into a larger context, VRI was used to assess wetland presence and distribution within the RSA. VRI contains basic information on wetland presence and distribution on the landscape. To identify wetlands in the RSA, Geographic Information System (GIS) analysis was conducted. VRI spatial files were overlaid with a spatial file of the RSA.

15.4.2.4 Old-growth Forests

Old-growth Management Areas (OGMAs) are areas where characteristics of old-growth forests are established and protected under FRPA. Some of these characteristics include coarse woody debris, arboreal lichen, broken tops on live and dead trees, and large old trees. OGMAs are also used to maintain other important sites such as rare ecosystems and wildlife habitat features. OGMAs for the Barriere and Vavenby LUs were effective March 5, 2013 ((BC MFLNRO 2013).

Old-growth forests within the LSA and RSA were identified using more recent (2012) VRI and projected ages 141-250, and >250.

15.4.3 Existing Conditions

15.4.3.1 Rare Plants

During baseline studies a total of 564 vascular plant taxa, 146 mosses, and 331 lichens were recorded in the LSA. Two BC Red- and five Blue-listed vascular plant taxa are known to occur within the LSA (Table 15.4-1). This includes occurrences found during the 2011 and 2012 surveys. No SARA Schedule 1 vascular plant taxa were found. No vascular plant species ranked by COSEWIC as Extinct, Extirpated, Endangered, Threatened, or Special Concern were found.

In addition, two other potential vascular plant taxa were found that appear to be undescribed species (see the bottom of Table 15.4-1).

Table 15.4-1. Rare Vascular Plants Found within the Local Study Area

Species	Total Occurrences	BC List	Provincial Status	Global Status
Agoseris lackschewitzii (pink agoseris)	1	Blue	S2S3	G4
Carex praeceptorum (teacher's sedge)	1	Red	S1S3	G4G5
Carex scopulorum var. *bracteosa* (Holm's Rocky Mountain sedge)	1	Blue	S2S3	G5T3T5
Isoetes howellii (Howell's quillwort)	5	Red	S1	G4G5
Pellaea gastonyi (Gastony's cliff-brake)	2	Blue	S2S3	G2G3
Sagina nivalis (snow pearlwort)	1	Blue	S2S3	G5
Stellaria obtusa (blunt-sepaled starwort)	1	Blue	S2S3	G5

Five BC-listed moss species were identified within the LSA during baseline surveys (Table 15.4-2). Three of the taxa are Red-listed in BC and the remaining two are Blue-listed. No SARA Schedule 1 mosses were reported, nor were any COSEWIC Extinct, Extirpated, Endangered, Threatened, or Special Concern moss species located.

Table 15.4-2. Rare Mosses Found within the Local Study Area

Species	Total Occurrences	BC List	Provincial Status	Global Status
Encalypta brevipes (no common name)	1	Blue	S2S3	G3
Orthotrichum cupulatum (hooded bristle-moss)	1	Blue	S2S3	G4G5
Pseudoleskea incurvata var. *tenuiretis* (no common name)	1	Red	S1S3	G5TNR
Psilopilum cavifolium (little wolverine moss)	1	Red	S1S2	
Warnstorfia tundrae (tundra warnstorfia)	1	Red	S2	GU

During baseline surveys 21 BC-listed lichen species were documented within the LSA (Table 15.4-3). No SARA Schedule 1 lichens were found. No COSEWIC Extinct, Extirpated, Endangered, Threatened, or Special Concern lichens were found.

Table 15.4-3. Rare Lichens Found within the Study Area

Species	Total Occurrences	BC List	Provincial Status	Global Status
Collema bachmanianum (Caesar's tarpaper)	1	Red	S2	GNR
Collema cristatum var. *marginale* (fingered tarpaper)	1	Red	S2	G3G5TNR
Collema polycarpon (gilled tarpaper)	1	Red	S2	GNR
Dermatocarpon atrogranulosum (charred stippleback)	1	Red	S1	GNR
Dermatocarpon leptophyllodes (jigsaw stippleback)	1	Blue	S2S4	GNR
Hypogymnia recurva (recoiling bone)	1	Red	S1S3	GNR
Lempholemma polyanthes (mourning phlegm)	1	Blue	S2S3	GNR
Leptogium intermedium (fourty-five vinyl)	1	Blue	S2S3	GNR
Leptogium plicatile (starfish vinyl)	1	Blue	S3?	G3?
Peltigera castanea (chestnut pelt)	1	Red	S1	GNR
Phaeophyscia adiastola (granulating shadow)	1	Red	S1	G4?
Phaeophyscia ciliata (greater eye shadow)	1	Blue	S2S3	G4G5
Phaeophyscia decolor (lesser eye shadow)	1	Blue	S2S3	G3G5
Phaeophyscia kairamoi (five o'clock shadow)	1	Blue	S3	G3G4
Phaeophyscia nigricans (least shadow)	1	Red	S1	G4
Physciella chloantha (downside shade)	1	Blue	S3	G5?
Placynthium asperellum (sandpaper ink)	1	Blue	S3?	G3G5
Placynthium stenophyllum var. *isidiatum* (sepia ink)	1	Blue	S3	G2G4T2T4
Synalissa symphorea (eyed rockgorgon)	1	Blue	S3	GNR
Thallinocarpon nigritellum (black rocklicorice)	1	Blue	S3	G4G5
Thyrea confusa (candied gummybear)	1	Blue	S2S3	G3G5

Please see Appendix 15-A for more detailed descriptions of the rare plant species.

Undescribed Species

Two potential vascular plant taxa were found that appear to be undescribed species (Table 15.4-4). One potentially new (previously undescribed) moss species (*Sphagnum* sp. nov.) was found in the LSA (Table 15.4-4). Of note, four lichen species were discovered that are believed to be new records for BC (Table 15.4-4), and hence are not yet assigned a status by the BC CDC. In addition, two potential lichen taxa that appear to be new species were documented in the LSA.

Table 15.4-4. Previously Undescribed and New to British Columbia Plant Species

Species	Total Occurrences	Taxa
Poa sp. (undescribed bluegrass)	1	Vascular
Rorippa sp. (undescribed yellowcress)	2	Vascular
Sphagnum sp. nov. (no common name)	1	Moss
Anema nodulosum (no common name)	1	Lichen
Lempholemma chalazanum (no common name)	1	Lichen
Peccania subnigra (no common name)	1	Lichen
Physconia isidiomuscigena (no common name)	1	Lichen
Lichinella sp. nov. (no common name)	1	Lichen
Placidiopsis sp. nov. (no common name)	1	Lichen

15.4.3.2 Ecological Communities at Risk

Of the 12 ECAR identified as potentially occurring within the LSA, three were mapped within the TEM (Table 15.4-5). Two of these ECAR are forested communities, while the third is associated with fens. All three of these ECAR are Blue-listed by the BC CDC.

Table 15.4-5. ECAR Identified within the LSA

Common Name	Latin Name	BC List	Site Series
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.	Blue	ESSFwc2/09
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	Blue	ESSFwc2/Wf11
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	Blue	IDFmw2/04

Site series that support the western redcedar – paper birch / oak fern ECAR are the most common within the LSA (104.2 ha). They are found at lower elevations in the LSA, while the Lodgepole pine / dwarf blueberry / peat-mosses associated and tufted clubrush / golden star-moss associated site series are less common (20.3 ha and 3.4 ha, respectively) and are typically found at higher elevations.

Site series associated with the Lodgepole pine / dwarf blueberry / peat-mosses and tufted clubrush / golden star-moss ECAR are found primarily near the proposed open pit footprint, with smaller areas overlapping the TMF, mine access road, and non-PAG waste rock footprints .

Site series associated with the western redcedar – paper birch / oak fern ECAR are located along the valley bottom of the North Thompson River, with some areas overlapping the mine access road footprint.

15.4.3.3 Wetlands

Eight wetland site series were identified in the TEM for a total of 205.8 ha of wetland within the LSA. These wetlands were distributed amongst the five BGC variants within the LSA. The most common wetland was 125.1 ha of water sedge / peat-moss in the ESSFwc2 and ESSFwcp. The majority of wetlands (96%) within the LSA were located at higher elevations, within the ESSF variants.

To provide a regional comparison, wetland abundance in the VRI were compared to that mapped in the TEM. Only 60 ha of wetlands were identified within the LSA using the VRI. This indicates that the VRI underestimates the amount of wetlands compared to the TEM, which has a much higher degree of field confirmation. Within the RSA, 693 ha of wetlands were identified in the analysis of the VRI. Of these, 77% are found within the ESSF, at a similar elevation to the Project Site, indicating that wetlands occur more commonly in the BGC units that the Project is predominantly sited in.

15.4.3.4 Old-growth Forests

Approximately 3093.6 ha (28%) of the LSA was mapped as old-growth forests (structural stage 7) according to the TEM. This TEM information is based on air photos from before 2000 and may be considered out of date. Over half of the old-growth forests are located in the ESSF variants, at higher elevations of the LSA and overlapping with much of the proposed Project footprints.

Updated information from the VRI indicates 2442 ha of forest (>140 years) and of this 536 ha greater than 250 years within the LSA. There are also 1,192 ha of designated OGMA within the LSA.

Extensive logging in the LSA has greatly affected the quantity of old-growth forests. Much of the LSA is structural stages 3 and 4 (shrub and pole / sapling) which is the result of logging in the past 20 to 40 years ago. The pattern of cutblocks and old-growth forests has left the LSA highly fragmented.

15.5 EFFECTS ASSESSMENT AND MITIGATION

15.5.1 Screening Potential Project Effects

Potential effects on Vegetation VCs by the Project have been raised during working group meetings by Aboriginal groups and government, and have been identified through best management practices, scientific literature, and technical expertise/professional judgment. Potential effects are analyzed and discussed in this section (Section 15.5.1.). A detailed description of the potential effects is provided in Section 15.5.1.1.

Potential effects will vary from Construction and Operations through to Closure and Post-Closure depending on Project components and activities during each of these phases. Table 15.5-1 describes the risk ratings (low, moderate, and high) of potential effects of each Project component and activity for each VC over every Project phase.

Table 15.5-1. Risk Ratings of Project Effects on Valued Components

Category	Rare Plants	Ecological Communities at Risk	Wetlands	Old-growth Forests
Construction				
Concrete production	🟢	🟢	🟢	🟢
Dangerous goods and hazardous materials	🟢	🟢	🟢	🟢
Environmental management and monitoring	🟢	🟢	🟢	🟢
Equipment	🟡	🟡	🟢	🟢
Explosives	🟢	🟢	🟢	🟢
Fuel supply, storage and distribution	🟢	🟢	🟢	🟢
Open pit	🟡	🟡	🟡	🟡
Potable water supply	🟢	🟢	🟢	🟢
Power supply	🟢	🟢	🟢	🟢
Processing	🟡	🟢	🟢	🟢
Procurement and labour	🟢	🟢	🟢	🟢
Project Site development	🔴	🔴	🔴	🔴
Rail load-out facility	🟡	🟢	🟢	🟢
Roads	🟡	🟡	🟡	🟡
Stockpiles	🟡	🟡	🟡	🟡
Tailings management	🔴	🟡	🔴	🟡
Temporary construction camp	🟡	🟡	🟢	🟢
Traffic	🟡	🟡	🟢	🟢
Waste disposal	🟢	🟢	🟢	🟢
Water management	🟡	🟡	🟡	🟢

(continued)

Table 15.5-1. Risk Ratings of Project Effects on Valued Components (continued)

Category	Rare Plants	Ecological Communities at Risk	Wetlands	Old-growth Forests
Operations 1				
Concentrate transport	●	●	●	●
Dangerous goods and hazardous materials	●	●	●	●
Environmental management and monitoring	●	●	●	●
Equipment	●	●	●	●
Fuel supply, storage, and distribution	●	●	●	●
Mining	●	●	●	●
Ore processing	●	●	●	●
Potable water supply	●	●	●	●
Power supply	●	●	●	●
Processing	●	●	●	●
Procurement and labour	●	●	●	●
Rail load-out facility	●	●	●	●
Reclamation and decommissioning	●	●	●	●
Stockpiles	●	●	●	●
Tailings management	●	●	●	●
Traffic	●	●	●	●
Waste disposal	●	●	●	●
Water management	●	●	●	●
Operations 2				
Processing	●	●	●	●
Reclamation and decommissioning	●	●	●	●
Tailings management	●	●	●	●
Water management	●	●	●	●
Closure				
Environmental management and monitoring	●	●	●	●
Open pit	●	●	●	●
Procurement and labour	●	●	●	●
Reclamation and decommissioning	●	●	●	●
Stockpiles	●	●	●	●
Tailings management	●	●	●	●
Waste disposal	●	●	●	●
Post-Closure				
Environmental management and monitoring	●	●	●	●

(continued)

Table 15.5-1. Risk Ratings of Project Effects on Valued Components (completed)

Category	Rare Plants	Ecological Communities at Risk	Wetlands	Old-growth Forests
Post-Closure (*cont'd*)				
Open pit	●	●	●	●
Procurement and labour	●	●	●	●
Stockpiles	●	●	●	●
Tailings management	●	●	●	●

Notes:
○ = *No interaction expected; no monitoring required, no further consideration warranted.*
● = *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; if minor, may require monitoring; may warrant further consideration.*
● = *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*
● = *Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

To better categorize effects, potential effects of the Project were divided into two categories: loss and alteration. Loss occurs when project footprints overlap the location of a VC and Project activities such as vegetation clearing or construction result in the removal of the VC and loss of the functions it provides. Alteration is used to indicate a change in the quality of habit or functions provide by an ecosystem due to project effects. Alteration occurs along project edges or linear corridors such as roads and may extend out from these edges such as where dust fall or edge effects occur.

To assess these effects, a footprint base approach was taken. Loss was assessed where spatial overlap of Project footprints and VCs occurred. Potential causes of alteration were identified: fugitive dust, contaminants, introduction of invasive plant species, and edge effects (Table 15.5-2). These were assessed based on expert opinion.

Table 15.5-2. Summary of Potential Project Effects on Vegetation Valued Components

Potential Effect Category	Potential Effects Considered	Phase in which Potential Effects may Occur		
		Construction	Operation	Closure and Post-Closure
Loss	Loss of VC	X	X	-
Alteration	Fugitive dust	X	X	-
	Contaminants	X	X	-
	Invasive species	X	X	X
	Edge effects	X	X	-

"X" indicates that the potential effect may occur during the identified Project phase
"-" indicates that the effect will not occur as a result of the Project, and is therefore scoped out of the effects assessment or not assessed for a particular phase (details are provided in Sections 16.5.1.2 through 16.5.1.4).

15.5.1.1 Loss and Alteration of Vegetation Valued Components

Loss

Loss of VCs within the Project footprint will occur primarily during Construction and Operation. No additional loss is expected during Closure or Post Closure. The amount of loss was calculated by overlaying the Project footprint with rare plant locations, ECAR, wetlands, and old-growth forests. Clearing of vegetation and grubbing during site preparation for the various facilities will cause the greatest amount of loss in the early stages of Project Construction. Much of the middle of the TMF is high-suitability rare plant habitat. This area is an interconnected system of low-gradient creeks, fens, wet and dry meadows, and upland forests. Late in Construction, filling of the TMF will lead to additional loss of wetlands, old-growth forests, and ECAR.

Wetlands and old-growth forests will be lost during construction of the diversion channels, east overburden stockpile, embankments, explosives storage site, haul road, Project Site road, north topsoil stockpile, open pit, PAG low-grade stockpile, pipelines, plant site, ponds, TMF, TMF seepage collection ponds, and Project Site power line. Old-growth forests will be lost during construction of the crusher/conveyor, non-PAG low-grade stockpile, north non-PAG waste rock stockpile, quarry site, south topsoil stockpile, and west topsoil stockpile. During Operations additional vegetation clearing, facility expansion, and TMF flooding will result in the loss of rare plant occurrences, ECAR, wetlands, and old-growth forests.

Alteration

For plants, ecosystems provide the biotic and abiotic conditions upon which they rely to obtain nutrients, water, and sunlight. Alteration of environmental conditions can cause changes in the functions of an ecosystem or the suitability of an area to support rare plants. The magnitude and direction (positive or negative) of the change depends on the ecosystem or species being considered. The potential effects of fugitive dust, contaminants, invasive plant species, and edge effects are discussed below.

Potential Fugitive Dust Effects

Fugitive dust generated by Project-related activities will be dispersed from its place of origin to depositional areas and may accumulate in or on soil and vegetation. An air quality model was developed for the Project for the Construction and Operations phases; this model incorporated mitigation measures intended to protect air quality (as described in Chapter 9, Air Quality Effects Assessment and the Air Quality Management Plan, Section 24.2). Predictions for fugitive dust deposition from the air quality model (Chapter 9) were used to determine the areas that are predicted to be most affected by dust deposition. Dust deposition rates were used as a qualitative measure of the potential for change in the habitat quality (i.e., soil and vegetation) of affected areas.

Dust deposition will occur during Construction but is expected to be highest during the Operations Phase. Most fugitive dust is projected to be deposited close to source within the working areas of the mine, but some dust will potentially be deposited beyond the disturbed Project footprint. Concentrations greater than 1.9 mg/dm^2/day could occur near the pit and along the access road at (BC MOE 1979). A small area at the northwest corner of the pit that extends approximately 650 m

from the Project footprint (Figure 9.5-6, Chapter 9, Predicted Maximum 30-day Dust Deposition) may be altered due to dust deposition, and dust may disperse up to approximately 200 to 300 m along approximately 2 km of the access road (Figure 9.5-6).

Dust deposition has the potential to affect several ha of wetlands, ECAR, and several incidences of rare plants northwest of the open pit. Both physical and chemical effects to plants occur as a result of dust deposition (Walker and Everett 1987; Farmer 1993a; Padgett et al. 2007). Plant communities may become altered due to a shifting competitive balance between certain species (Walker and Everett 1987; Farmer 1993a). The most at risk species identified are epiphytic lichens and sphagnum communities (Walker and Everett 1987; Farmer 1993a). No rare-lichens are expected to be influenced by dust deposition as a result of Project Construction.

Potential Contaminant Effects

Toxicity due to exposure to Project-related contaminants was identified as a potential habitat-altering effect that could occur during Construction, Operation, or during Closure. In particular, changes to water quality have the potential to affect wetland function. Closure and Post-Closure water quality was predicted using a water quality model (Chapter 13, Surface Water Quality Effects Assessment, and Appendix 13-C, Surface Water Quality Predictive Model). Some loss of water from the TMF is expected through seepage; this was considered in the water quality model (Appendix 13-C). Based on the predictions of the water quality model selenium, mercury, molybdenum, and fluoride all have the potential to be lost through seepage, although the particle tracking results discussed in the groundwater effects assessment (Chapter 11) predict groundwater seepage from the TMF to occur on the northern side of T-Creek, towards the open pit and towards Jones Creek (Figure 11.5-11), all areas containing few wetlands.

Run-off from Project roads may be contaminated with salt or other de-icing materials, silt, oil, and other fluids from machinery. Vehicles and machinery could potentially introduce oil and other contaminant fluids through spills. Plant species that are more tolerant to the chemicals used would be expected to replace species that are more sensitive, which may change the species composition of rare communities. The potential for contaminated runoff from Project roads during Closure will be lower due to the much-reduced workforce

Potential Invasive Species Effects

Invasive species have the potential to negatively affect native plant and animal communities, especially where native biodiversity has been reduced by other impacts (Dukes 2002). The effects of invasive species on native diversity have been well documented, are growing in magnitude, and are the second greatest threat to listed species after habitat loss (Wilcove et al. 1998; Enserink 1999).

Invasive plants are often found along road verges and other recently disturbed areas. Once established, they can decrease vegetation biodiversity, forest and range productivity, and ultimately reduce the overall efficacy of reclamation initiatives (Polster 2005). Vehicles and machinery can carry plant propagules in their tires, undercarriages, or in mud on the vehicle, inadvertently transporting them to previously unaffected areas. In addition to roadside ditches and verges, forest edges are susceptible to the introduction of invasive species propagules from adjacent clearings (Murphy and Lovett-Doust 2004).

Ground disturbance during maintenance activities may result in the establishment and spread of invasive species (Invasive Species Council of British 2014). Weed seeds may be dispersed accidentally by machinery and establish in disturbed areas where native vegetation has been reduced or stripped. Once established, seeds from new populations may be carried by wildlife, domestic stock, wind, and water to new locations. Invasive species can often out-compete native vegetation, especially on disturbed sites.

Risk of invasive species introduction is greatest during Construction and Operation, although Closure activities will still have the potential to introduce invasive plant species within the LSA, particularly during reclamation.

Potential Edge Effects

Clearing activities may also have indirect effects on nearby rare plant occurrences and habitat not directly located within the Project footprints. Most measurable physical environmental effects on vegetation associated with linear features such as roads appear not to extend beyond a distance of 100 m. Many of the changes associated with microclimate occur within one tree length of the dominant trees (Spittlehouse, Adams, and Winkler 2004). Some Project footprints, such as the Project Site power line ROW, will be maintained in a grass-shrub successional stage. Periodic brushing will be used to limit tree growth, delaying, or preventing recovery of forested ecosystems.

Edge effects will occur during construction and will continue through operation and closure until reclamation is complete. Effect due to alteration could include:

- increased incidental human disturbance (foot and vehicle traffic, recreation by workers, etc.);
- changes in the abundance of pollinators and animal dispersal vectors due to altered nearby habitat; and
- changes in microclimate, soil chemistry, snow depth, wind throw, regeneration, and vegetation (Huggard and Vyse 2002).

15.5.2 Mitigation Measures

The *Canadian Environmental Assessment Act, 2012* (2012) defines mitigation measures as "measures for the elimination, reduction or control of the adverse environmental effects of a designated project, and includes restitution for any damage to the environment caused by those effects through replacement, restoration, compensation or any other means." In order to reduce adverse Project effects, three general categories of mitigation will be applied:

1. impact avoidance;
2. impact reduction and technical mitigation; and
3. reclamation.

15.5.2.1 Impact Avoidance –Reducing Loss Effects

Impact avoidance is the avoidance of direct or indirect impacts through the modification of Project facilities and their placement, or through modification of construction and operations methods. Through the implementation of these measures, Project effects are reduced or eliminated. Impact avoidance is only possible in certain locations where complete avoidance of VCs or their habitat is feasible.

As a part of Project design to date, some footprints proposed early in the design were altered to reduce effects to sensitive locations, including rare plant occurrences, old-growth forests, and wetlands. The footprint located to the west of the pit was reduced, where earlier designs had a large stockpile at this location. The current northwest soil stockpile is smaller than the earlier design.

Additional impact avoidance mitigation proposed for the Project in the Vegetation Management Plan (Section 24.17) includes:

- Known VC occurrences located adjacent to construction and operation areas will be clearly flagged to discourage accidental encroachment with machines. Signage will be added where necessary to indicate the boundaries of the exclusion area.
- Construction and operating personnel will attend a field-based orientation session where the exclusion areas will be explained, and the importance of avoiding disturbance within them will be stressed.
- A spatial database and maps of known rare plant locations in the vicinity of Project facilities should be maintained and consulted to avoid impacts during Operations and maintenance activities. The database should be actively updated as new information becomes available.

15.5.2.2 Impact Reduction and Technical Mitigation – Reducing Alteration Effects

Impact reduction and technical mitigation is the lessening of direct and indirect impacts to VCs, their occurrences, and suitable habitat through the targeted modification of construction and operations methods. Impact reduction can be applied in the same general locations as described above for impact avoidance but is restricted to those areas where only partial avoidance is feasible.

- Vegetation loss will be minimized during Project Construction and Operation. Sensitive ecosystems will be avoided where practical.
- Roads and transmission lines will be designed to minimize the number of water crossings and to avoid running parallel in close proximity to watercourses.
- Clearing activities will include low-impact techniques such as hand clearing and topping where practical.
- Erosion prevention and bank stabilization techniques will be used to minimize potential for secondary loss of trees after initial clearing efforts.
- Known VC occurrences located adjacent to construction and operation areas will be clearly flagged to discourage incidental disturbance. Signage will be added where necessary to indicate the boundaries of the exclusion area.

- Construction and operating personnel will attend a field-based orientation session where the exclusion areas will be explained, and the importance of avoiding disturbance within them will be stressed.

Specific details on impact reduction mitigation measures for vegetation VCs are provided in the Vegetation Management Plan in Section 24.18.

Fugitive Dust Effects

Dust mitigation measures, in particular related to fugitive dust, addressed in these documents will mitigate effects to vegetation VCs. Mitigation measures to protect air quality are described in Chapter 8, Assessment Methodology, (Section 8.6.2) and in the Air Quality and Dust Management Plan (Section 24.2). Reducing traffic by implementing the Traffic and Access Management Plan (Section 24.16) will also reduce the potential for negative effects of dust. These measures will mitigate the potential effects of fugitive dust altering vegetation VCs.

Contaminant Effects

The Fuel and Hazardous Materials Plan (Section 24.7), the Spill Prevention and Response Plan (Section 24.16), and the Waste Management Plan (Chapter detail measures intended to prevent and mitigate the effects of deleterious substances discharged into the environment. All activities that involve potentially harmful or toxic substances such as oil, fuel, antifreeze, and concrete will follow approved work practices that will be laid out in these plans. They also detail emergency response procedures should a spill occur.

Mitigation measures to protect water quality were described in Chapter 13, Surface Water Quality Effects Assessment (Section 13.5.2). Mitigation measures are also described in various management plans including:

- Mine Waste and ML/ARD Management Plan (Section 24.9);
- Groundwater Management Plan (Section 24.8);
- Sediment and Erosion Control Plan (Section 24.11);
- Water Management Plan (Section 24.13);
- Fuel and Hazardous Materials Management Plan (Section 24.7);
- Air Quality and Dust Management Plan (Section 24.2);
- Site Water Management Plan (Section 24.13); and
- Selenium Management Plan (Section 24.12).

These measures were considered highly effective at reducing the probability and effects of contaminants negatively altering rare plants, ECAR, wetlands, and old-growth forests.

Invasive Species Effects

Development and implementation of an invasive plant species plan and other measures identified in the Vegetation Management Plan (Section 24.17) are integral to reducing invasive species introduction. Avoiding introducing invasive species is central to circumventing costly measures required for their eradication to protect rare, plants, ECAR, wetland functions and old-growth forest habitat. Reducing traffic by implementing the Traffic and Access Management Plan (Section 24.16) on site is also a key measure to help reduce the introduction of invasive plant species.

The plan for invasive species will manage for the priority species throughout the Project area. A site-specific plan will be developed by the Project's Environmental Supervisor. The plan will draw upon the *Invasive Alien Plant Program: Reference Guide* (BC MOFR 2010), which outline an Integrated Pest Management approach for invasive alien plants, under the authority of several partnering ministries.

Reclamation to restore affected areas after Project activities have ceased in those areas will reduce favourable conditions that could allow the establishment of invasive species. The reclamation plan provides for the rapid re-vegetation of all temporarily disturbed areas and will use appropriate seed mixes that minimize the spread of invasive plants.

The implementation of the invasive species management plan in combination with the Traffic and Access Management Plan (Section 24.16) and Closure and Reclamation Plan (Chapter 7) were considered successful in mitigating invasive species effects.

Edge Effects

As access roads are already in place and require only modification; edge effects associated with roads will be negligible and will be managed by Traffic and Access Management Plan (Section 24.16). Edge effects will be minimized through the implementation of the Vegetation Management Plan (Section 24.17) by conducting windthrow mitigation measures in areas with high windthrow risk as described in the Vegetation Management Plan (Section 24.17). Concurrent and prompt reclamation, as detailed in the Closure and Reclamation Plan (Chapter 7), will ensure prompt re-vegetation of disturbed sites and mitigate effects along edges.

Construction activities will be designed and carried out in a manner that minimizes impacts to the hydrology of adjacent wetlands (those not directly removed by the Project). Adequate culverts will be placed under access roads, and sedimentation barriers will be used as needed, as per the Site Water Management Plan (Section 24.13) prepared for the Project. This will mitigate edge effects on wetlands and alteration of soil hydrology along edges.

15.5.2.3 Valued Component Mitigation Measures and Potential Residual Effects

Specific mitigation measures and Project effects on rare plants, ECAR, wetlands, and old-growth are proposed in the Vegetation Management Plan (Section 24.17) and are summarized below. The effectiveness of all proposed mitigation and the potential for residual effects after mitigation is applied has been assessed for each VC. The definitions for each of the effectiveness ratings are:

- Unknown - Mitigation effectiveness is unknown or implementation methods are not clearly identified;
- Low - Mitigation effectiveness is low, or implementation is not easy or widely applicable;
- Moderate - Mitigation is moderately effective and operationally implementable; and
- High - Mitigation measure is highly effective and operationally implementable.

Rare Plants

Specific mitigation measures for rare plants are outlined in the Vegetation Management Plan (Section 24.17). Avoidance measures, flagging protective buffers around known locations, dust control, culvert placement, re-vegetation planning, and invasive species management are mitigation tools that will reduce the probability of effects on rare plants.

The effectiveness of mitigation and potential residual effects on rare plants are presented in Table 15.5-3. Residual effects to rare plants and suitable habitat are addressed together.

Table 15.5-3. Proposed Mitigation Measures for Rare Plants and their Effectiveness and Potential Residual Effect

Rare Plants			
Potential Effect	**Proposed Mitigation Measure**	**Effectiveness *(Low, Moderate, High, Unknown)***	**Potential Residual Effect (Y/N)**
Loss	Avoidance, flagged buffers, reclamation of wetlands, regional surveys within the ESSFwc2.	Low (limited application)	Y
Alteration	Fugitive dust management, contaminants control measures, invasive plant species control, water quality and quantity measures, reclamation.	Moderate to High	N

Twelve known rare plant occurrences will be lost as a result of Project Construction (see Table 15.5-8 for a list of all known rare plant occurrences in Project footprints), and the loss of rare plant occurrences will not be fully mitigated. Howell's quillwort is Red-listed and S1 (critically imperiled) in BC, and is only known from a few occurrences in other areas of the province. All five individuals identified in the LSA will be lost due to the Project. The loss of these individuals is likely to be permanent; rare plant conditions are not expected to return to pre-Construction conditions. To mitigate potentially regional effects on the Howell's quillwort population, additional surveys for Howell's Quillwort and ECAR will be completed in the Northern Monashee Wet Cold Engelmann Spruce – Subalpine Fir variant (ESSFwc2), within the RSA to determine the extent of other occurrences, and provide a regional perspective on the known occurrences within the Project area (See Section 24.17.3). This effect may be lessened if other occurrences are found in the area.

Alteration to rare plants is expected to be mitigated by the management plan measures related to dust and water quality and quantity. One rare moss is located within 100 m of the Open Pit and within maximum predicted dustfall. Two rare plant locations occur within the Project Site area but

are over 200 m northwest of the Open Pit (Figure 15.5-1). Due to the distance from the pit and the proposed mitigation measures, no Project effects are anticipated on these species. No residual effects due to alteration are expected on rare plants.

Ecological Communities at Risk

Specific mitigation measures for ECAR are outlined in the Vegetation Management Plan (Section 24.17) including: marking of vegetation clearance boundaries to minimize unnecessary disturbance beyond the development area; construction areas will be limited to the narrowest operationally viable width through known ECAR ecosystems; and focussing restoration activities on ECAR. Avoidance measures and mitigation for dust hydrologic changes, re-vegetation planning, edge effects, and invasive species management will help mitigate Project effects on ECAR. Applicable mitigation measures and the effectiveness of mitigation are presented in Table 15.5-4.

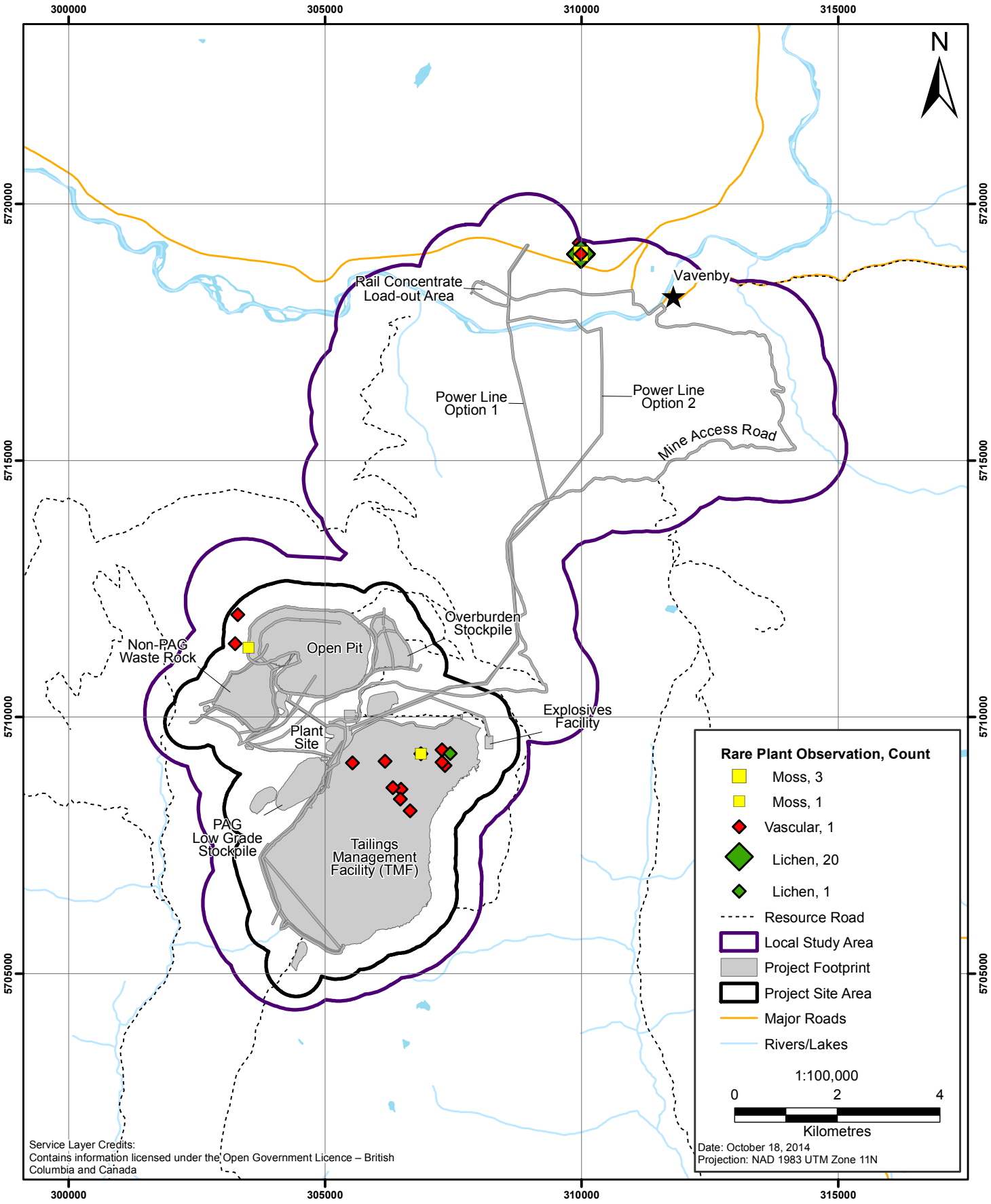
Table 15.5-4. Propose Mitigation Measures for Ecological Communities at Risk and their Effectiveness and Potential Residual Effect

Ecological Communities at Risk			
Potential Effect	**Proposed Mitigation Measure**	**Effectiveness** ***(Low, Moderate, High, Unknown)***	**Potential Residual Effect (Y/N)**
Loss	Avoidance, flagged buffers, reclamation of ECAR, regional surveys within the ESSFwc2.	Low (limited application)	Y
Alteration	Windthrow management, buffers, avoidance, dust management, contaminants control measures, invasive plant species control, reclamation.	Moderate	N

Potential residual effects on ECAR are presented in Table 15.5-4. The majority of effected ECARs within the LSA are found within the TMF. Approximately 9.3 ha (46%) of ESSFwc2/09, 3.4 ha (100%) of ESSFwc2/Wf11 and 1.2 ha (1.1%) of IDFmw2/04 will be lost as a result of Project Construction and Operations. The greatest effect will be the loss of the tufted clubrush /golden star moss ECAR (ESSFwc2/Wf11) identified within the LSA. This effect may be lessened if additional occurrences are found outside of footprints. This fen has an incidental distribution (<5% of wetlands) in the ESSF (MacKenzie and Moran 2004). Loss of ECAR will not be reversible through reclamation or time. A residual effect is expected.

Several hectares of ECAR occur northwest of the open pit. The closest of these intersects the pit and alteration due to fugitive dust deposition and edge effects will occur. The other ECAR northwest of the pit is over 400 m from the pit and alteration caused by Project activities is not expected. Some alteration of ECAR functions within 100 m of the pit could occur due dust and edge effects. However, of the 17.1 ha TEM polygon, only 20% (3.42 ha) of this is ESSFwc2/09, identified as an ECAR. Only 2.2 ha of the 17.1 ha polygon falls within the 100 m buffer from the Project footprint and 7 ha of the polygon is already included as loss as it overlaps the pit. It is likely that mitigation measures such as surveys, avoidance, and buffers can be used successfully to mitigate effects. No residual effect is expected.

Figure 15.5-1
Rare Plant Observations



Wetlands

Mitigation measures for wetlands are outlined in the Vegetation Management Plan (Section 24.17). These include adequate culverts under access roads and sedimentation barriers to reduce changes to wetland hydrologic and biochemical functions. Wetlands along the Project Site power line will be clear-spanned (i.e., no poles erected within wetlands) and vehicles (tracked or wheeled) will avoid wetlands in this area. Characterization of residual effects and a complete list of applicable mitigation measures are included Table 15.5-5.

Table 15.5-5. Proposed Mitigation Measures for Wetlands and their Effectiveness and Potential Residual Effect

Wetlands			
Potential Effect	**Proposed Mitigation Measure**	**Effectiveness** *(Low, Moderate, High, Unknown)*	**Potential Residual Effect (Y/N)**
Loss	Avoidance, creation of pocket wetlands, flagged buffers, clear spanning wetlands of powerline.	Low (limited application)	Y
Alteration	Appropriate culverts, manage edge effects, dust management, contaminants control measures, invasive plant species control, reclamation.	Moderate	Y

The effectiveness of mitigation measures to reduce Project effects on wetlands is presented in Table 15.5-5. The Project has the potential to remove about 143 ha of wetlands in the LSA. All of this loss is of high-elevation wetlands—BGC variant ESSFwc2. This loss will last until Project Operations are complete; at which point reclamation will include the creation of pocket wetlands and reclamation of wetlands in several Project footprints (see Chapter 7, Closure and Reclamation). However, the success of wetland creation at high elevations is unknown and only 17.6 of the 143 ha will be reclaimed. A residual effect for wetland loss is expected.

Alteration of wetland function will occur where wetlands intersect Project footprints. Changes to hydrological functions, biochemical functions, ecological functions, and wetland functional diversity are likely to occur. Unmitigated effects due to dust, interruption of subsurface flows on wetlands may extend for several hundred meters and include:

- alterations to wetland hydrological function through subsidence, ditch construction, culverts, watercourse crossing, or other types of alteration of flow;
- alterations to wetland biochemical function through sedimentation, dustfall, site runoff, alteration of hydrology or point source discharge;
- alterations to wetland ecological function through the introduction of invasive plant species, changes in ecosystem function due to loss of adjacent wetland areas; and
- alterations to wetland habitat function through edge effects, change of vegetation structure, or change of water quality or quantity.

Mitigation will reduce the amount of alteration experiences by wetlands and most effects should be limited to less than 100 m from Project footprints. Alteration of wetlands is likely to occur to wetlands within 100 m of the pit and TMF and affect 7.5 ha of wetlands. Residual effects are likely in this area after mitigation.

Old-growth Forests

Mitigation measures for old-growth forests are identified in the Vegetation Management Plan (Section 24.17). These include avoidance, reclamation of disturbed areas, windthrow management of edges, and marking of vegetation clearance boundaries to minimize unnecessary disturbance beyond the development area. Limiting construction of road and other footprints to the narrowest operationally viable widths in old-growth ecosystems and focussing restoration activities adjacent to old-growth will also reduce effects. The effectiveness of mitigation and potential residual effects on old-growth are presented in Table 15.5-6.

Table 15.5-6. Proposed Mitigation Measure for Old-growth Forests and their Effectiveness and Potential Residual Effect

Old-growth			
Potential Effect	**Proposed Mitigation Measure**	**Effectiveness** *(Low, Moderate, High, Unknown)*	**Potential Residual Effect (Y/N)**
Loss	Avoidance, reclamation of disturbed areas, windthrow management, marking of vegetation clearance boundaries.	Low (limited application)	Y
Alteration	Windthrow management practices, dust management, invasive plant species control, reclamation.	High	N

The Project has the potential to remove up to 610 ha of the old-growth (greater than 140 years) forest and 213 ha of OGMA within the LSA. The old-growth in the LSA has been heavily fragmented by timber harvesting. High-elevation old-growth forests are more common regionally due to reduced access and because high-elevation old-growth has lower commercial value to forestry. Because of the large amount of old-growth in the LSA and RSA, the loss is considered a local effect. Mitigation will not be able to entirely compensate for the losses associated with Project Construction. The effectiveness of mitigation to reduce Project effects on loss of old-growth forests is presented in Table 15.5-5. A residual effect is expected to occur for loss of old-growth forests.

Alteration of old growth functions will be mitigated through the implementation of windthrow management practices, reduced road traffic and other dust control measures, invasive plant species control, and reclamation. Alteration of old-growth is not anticipated to have residual effects.

15.5.3 Predicted Residual Effects and Characterization

From the scoping assessment, two potential effect categories for vegetation VCs were identified: loss and alteration. The potential residual effects are discussed in further detail in the following sections for each vegetation VC followed by characterization of the residual effects (Section 15.5.3), significance determinations (Section 15.5.4) for each vegetation VC, and confidence of residual effects (Section 15.5.5).

The characterization and likelihood of effects considered results of vegetation baseline studies (Appendix 15-A), regional planning documents, and scientific literature. Detailed descriptions of the effects assessment methodology, logic, variables, and descriptors are in Chapter 8 (Table 8.6-2), Assessment Methodology. The residual effects were characterized according to the criteria provided in Table 15.5-7. All of these criteria were assessed to determine the significance of each residual effect (Section 15.5.4). In the majority of cases, professional judgement was also employed through a qualitative approach to assist in the determination of significance.

Table 15.5-7. Definitions of Residual Effects Characterization Criteria for Vegetation

Criterion	Description	Quantitative Measure or Definition of Qualitative Category
Direction	The overall trend of the VC relative to baseline	Positive: The abundance of the VC or availability of suitable habitat is increasing. Neutral: The abundance of the VC or availability of suitable habitat is not changing. Negative: The abundance of the VC or availability of suitable habitat is decreasing.
Magnitude	The amount of change relative to baseline conditions	Negligible: no detectable change from baseline conditions. Low: differs from the average value for baseline but remains within the range of natural variation. Medium: differs from the average value for baseline and approaches the limits of natural variation. High: differs substantially from baseline conditions and is significantly beyond a threshold value
Geographic Extent	The geographic area in which an effect of a defined magnitude occurs	Discrete: The extent of the effect will have sub-local (e.g., individual) implications to the VC. Local: The extent of the effect will have local (e.g., sub-population level) implications to the VC. Regional: The extent of the effect will have regional (e.g., population level) implications to the VC. Beyond regional: effect extends beyond the Regional Study Area.
Frequency	The number of times during the Project or phase that an environmental effect may occur	Once: Occurs once One time: effect is confined to one discrete event. Sporadic: Occurs more than once but is sporadic throughout the year. Regular: Occurs less than once a week, at regular intervals. Continuous: Occurs several times a week, at regular intervals.
Duration	The length of time required until the VC returns to baseline conditions, or the effect can no longer be measured or otherwise perceived	Short-term: Effect is limited to construction. Medium-term: effect lasts from 2 to 30 years (i.e., encompassing both stages of the Operations phase). Long-term: Effect lasts into Project operation but dissipates during the life of the Project. Future: Effect lasts during the life of the Project and possibly beyond.

(continued)

Table 15.5-7. Definitions of Residual Effects Characterization Criteria for Vegetation (completed)

Criterion	Description	Quantitative Measure or Definition of Qualitative Category
Reversibility	The ability of the affected VC to return (or be returned) to baseline conditions	Reversible: Effect reversible with reclamation and/or over time, or if the Project facilities were removed from the area. Partially reversible: effect can be partially reversed. Irreversible: Effect irreversible
Context	The extent to which the area affected has already been adversely affected by human activities, and is ecologically fragile with little resilience and resistance to imposed stresses	High: The area has been substantially disturbed by previous human development, or the focal taxa is adaptable to frequent natural disturbances. Neutral: The area has been moderately disturbed by previous human development, or the focal taxa is somewhat adaptable to disturbance. Low: The area is relatively pristine, or the focal taxa prefers long-term stability to thrive.
Level of Confidence	An evaluation of the scientific certainty in the review of Project-specific data, relevant literature, and professional opinion	Low: The effectiveness of mitigation or scale of the effect is poorly understood. Follow-up monitoring is recommended. Moderate: Greater certainty in understanding the effect, but some uncertainty exists in modelling or effects pathways. High: Detailed modelling has been done and effect pathways are understood.

Once mitigation is considered, any remaining potential effects of the Project on vegetation are identified as residual effects. The dominant effect to the VCs will be loss. Minor amounts of alteration of vegetation VCs due to Project effects will also occur. Of the four Project phases, Construction and Operations will have much greater effect than Closure and Post-Closure. The effects of Construction and Operations are very similar in many cases. Vegetation clearing of Project footprints will have the greatest impact on vegetation VCs during Construction. Vegetation clearing will continue through Operations as footprints expand. Many activities during Closure are considered to have a positive effect (e.g., reclamation of wetland sites), but the success of these activities are less-certain due to the long-term time frame of the Project and the uncertainty associated with reclamation success in high-elevation terrestrial ecosystems and wetlands.

The predicted residual effects were characterized according to the following criteria: direction, magnitude, geographic extent, frequency, duration, reversibility, context, and level of confidence (Table 15.5-7). All of these criteria were assessed to determine the significance of each residual effect. In the majority of cases, professional judgement was also employed through a qualitative approach to assist in the determination of significance.

Likelihood refers to the probability of the predicted residual effect occurring and is determined according to the attributes identified in Table 15.5-8.

Table 15.5-8. Definitions of Likelihood Characterization Criteria for Vegetation

Probability Rating	Quantitative Threshold
High	> P80 (effect has > 80% chance of effect occurring)
Moderate	P40 - P80 (effect has 40 - 80% chance of effect occurring)
Low	< P40 (effect has < 40% chance of effect occurring)

15.5.3.1 Rare Plants

Residual effects are those effects predicted to remain after the application of mitigation measures. Table 15.5-3 provides a summary of mitigation measures for rare plants, effectiveness of mitigation, and whether there is a potential for a residual effect after mitigation. For rare plants, residual effects were expected for loss but not alteration. Alteration to rare plants is excluded from further analysis. Potential Project effects to rare plants were quantified through spatial analysis. The proposed Project facilities footprint was assumed to be the area where direct effects to rare plants would be expected. Two general footprints were used: one to represent the area affected during Construction, and one to represent the additional area affected during Operations. Outside of these footprints, but within the LSA, it was assumed that loss of rare plants would not occur and no further losses would occur during Closure and Post-Closure.

Ten BC-listed vascular plant occurrences (six different taxa) occur within the Construction and Operations footprints (Table 15.5-9) and are expected to be lost. The 10 occurrences are located in the northern half of the proposed TMF (Figure 15.5-1).

Table 15.5-9. Number of Rare Plant Occurrences in Project Footprints

Species	BC List	Occurrences within Footprints	Taxonomic Group
Agoseris lackschewitzii (pink agoseris)	Blue	1	Vascular Plant
Carex praeceptorum (teacher's sedge)	Red	1	Vascular Plant
Carex scopulorum var. bracteosa (Holm's Rocky Mountain sedge)	Blue	1	Vascular Plant
Isoetes howellii (Howell's quillwort)	Red	5	Vascular Plant
Sagina nivalis (snow pearlwort)	Blue	1	Vascular Plant
Stellaria obtusa (blunt-sepaled starwort)	Blue	1	Vascular Plant
Total vascular plants		**10**	
Warnstorfia tundrae (tundra warnstorfia)	Red	1	Moss
Placynthium asperellum (sandpaper ink)	Blue	1	Lichen
Potential New Species (previously undescribed)			
Sphagnum sp. nov. (no common name)	-	1	Moss
Poa sp. (bluegrass)	-	1	Vascular Plant
Rorippa sp. (yellowcress)	-	2	Vascular Plant

One BC-listed moss occurrence and one BC-listed lichen occurrence occur in the footprint areas. The two occurrences are located in the northern half of the TMF and will be lost. The remaining four BC-listed moss occurrences and the 20 BC-listed lichen occurrences in the LSA are all outside the facilities footprints and no loss is expected.

Characterization of Residual Effect to Rare Plants - Loss

Loss of 25% of rare plant occurrences identified in the LSA as a result of the Project is a residual effect (Table 15.5-10). The effect is high-magnitude due to the relative amount of loss and that the loss is irreversible. Frequency is one time; vegetation clearing and alteration will only occur once per footprint. The greatest effect of the Project is the loss of the five individuals of the Red-listed and S1 (critically imperiled) rare plant, Howell's quillwort. There are only a few known occurrences within the province. Clearing of vegetation is expected to remove all five occurrences.

Table 15.5-10. Residual Effects to Rare Plants

Criterion	Characterization	Explanation
Direction	Negative	The overall loss of rare plant occurrences and suitable habitat will not be fully mitigated; therefore the total number of occurrences in the LSA will decrease.
Magnitude	High	12 rare plant occurrences known from the LSA are expected to be lost.
Geographic Extent	Regional	The greatest effect of the Project to rare plants is the loss of all Howell's quillwort occurrences in the LSA. It is Red-listed and S1 (critically imperilled) in BC, and only a few occurrences have been identified in the province.
Frequency	One time	The majority of Project effects to rare plants occur during TMF filling, stockpiling, and extraction. These are one-time events in any given area.
Duration	Future	Rare plant conditions within certain Project facilities are not expected to return to baseline beyond the life of the Project.
Reversibility	Irreversible	Rare plant conditions would not return to baseline conditions within certain Project facilities for the life of the Project and beyond.
Context	Low Resilience	Rare plants are dependent on local environmental factors.
Level of Confidence	Low	Although general predictions of adverse rare plant effects are sound, the specific disturbance responses for the rare plants in the LSA are unknown; distribution data within BC is incomplete for many of the affected rare plant taxa.

Likelihood for Residual Effects to Rare Plants - Loss

To determine the potential for the Project to cause residual effects, the likelihood of a residual effect occurring can be expressed as a measure of probability. The likelihood of a residual effect does not influence the determination of significance, rather it influences the risk of an effect occurring. Likelihood has been considered here in keeping with the most recent guidance issued in September 2013 by the BC Environmental Assessment Office (BC EAO; 2013b): *Guidelines for the Selection of Valued Components and Assessment of Potential Effects.*

Likelihood criteria are provided in Table 15.5-8. Likelihood of residual effects to rare plants is high as the locations of Project footprints are known and surveys for rare plants were focussed in these areas.

15.5.3.2 Ecological Communities at Risk

Table 15.5-4 provides a summary of mitigation measures for ECAR, effectiveness of mitigation, and whether there is a potential for a residual effect after mitigation. For ECAR, residual effects were expected for loss. Alteration to ECAR is excluded from further analysis.

Potential Project effects to ECAR were analysed spatially. Loss of ECAR in the proposed Project facilities footprint was the main effect to ECAR. Two general footprints were used: one to represent the area affected during Construction, and one to represent the additional area affected during Operations. Outside of these footprints, but within the LSA, it was assumed that loss of ECAR would not occur. Ecosystem mapping of ECAR was used to establish the extent of the expected residual effect. Of the 12 ECAR identified as potentially occurring within the LSA, three were mapped with the TEM (Table 15.5-11). Approximately 11% (13.9 ha) of all ECAR mapped in the LSA will be lost/removed as a result of Project Construction and Operations, including all 3.4 ha of the tufted clubrush /golden star moss and 9.3 ha or 46% of the Lodgepole pine / dwarf blueberry / peat-mosses ECAR. The majority of ECARs will be lost as a result of the TMF. Those ECAR that will be lost are restricted to a few localized areas within the LSA, and the effects of loss will only occur once per footprint (Figure 15.5-2).

Table 15.5-11. Total Ecological Communities at Risk located in LSA

Common Name	Latin Name	Area (ha) in LSA	Area (ha) in footprint	% Lost
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.	20.3	9.3	46 %
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	3.4	3.4	100 %
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	104.2	1.2	1.1 %

Characterization of Residual Effect to Ecological Communities at Risk - Loss

The loss of 11% of ECAR in the LSA is considered a residual effect with high magnitude (Table 15.5-12). The direction of change is negative and the effect is local in extent. Loss of ECAR will only occur once and will be irreversible as reclamation of ECAR has high uncertainty. Confidence in the prediction is moderate.

Likelihood for Residual Effects to Ecological Communities at Risk - Loss

Likelihood criteria are provided in Table 15.5-8. While the locations of Project footprints are known, the ability of TEM to accurately predict and spatially define ECAR is poor. The likelihood of effects occurring is moderate.

15.5.3.3 Wetlands

Table 15.5-5 provides a summary of mitigation measures for wetlands, effectiveness of mitigation, and whether there is a potential for a residual effect after mitigation. Residual effects for wetlands were expected for loss and alteration due to the proximity of many wetlands to footprints.

Figure 15.5-2
Ecological Communities at Risk - Associated Site Series

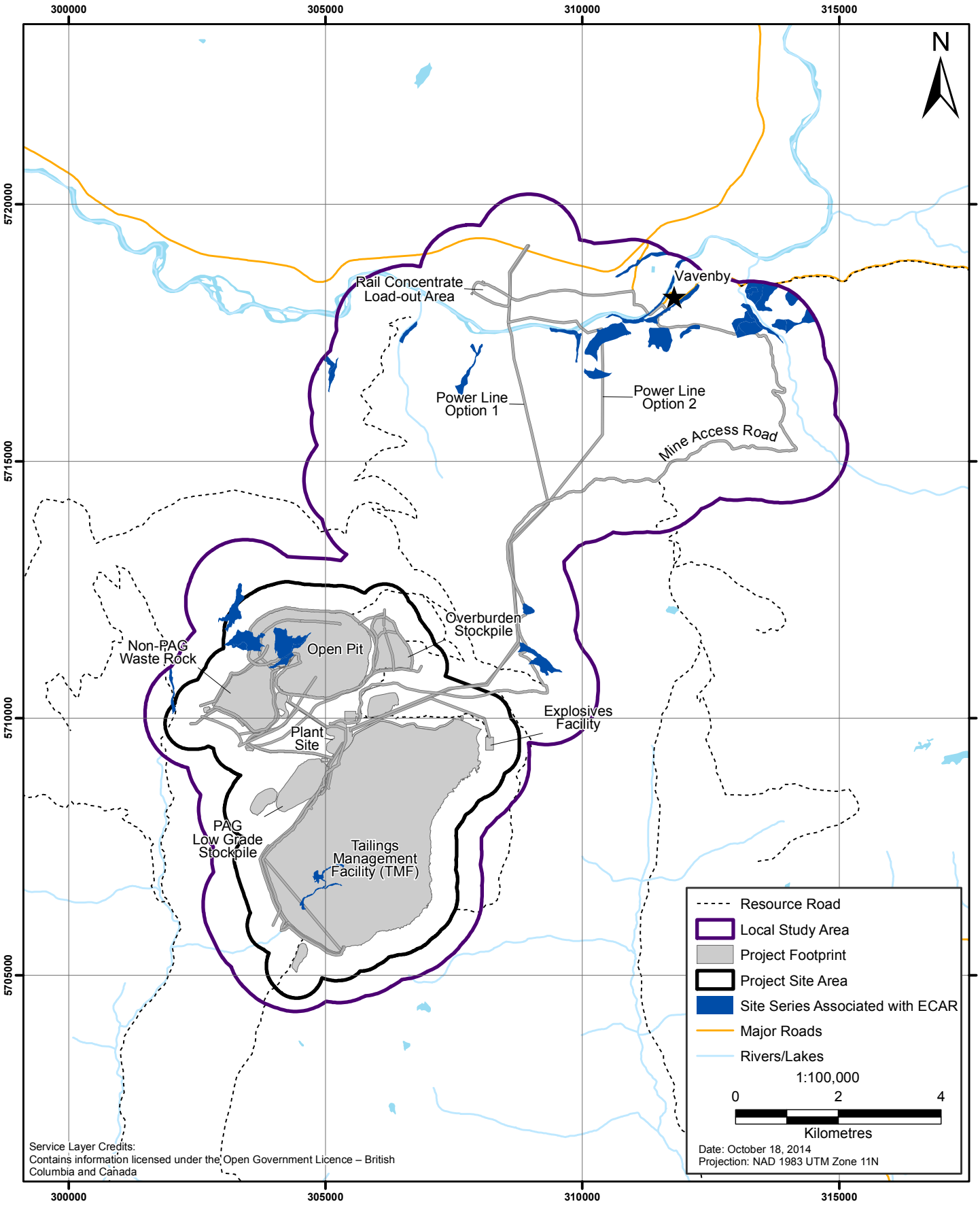


Table 15.5-12. Residual Effects to Ecological Communities at Risk

Criterion	Characterization	Explanation
Direction	Negative	There will be a loss of ECARs within the LSA.
Magnitude	High	The greatest effect to ECAR will be the loss of 3.4 ha of the tufted clubrush / golden star-moss ECAR within the LSA.
Geographic Extent	Local	ECAR effects are restricted to a few localized areas within the LSA.
Frequency	Once	Loss of ECARs will only occur once within any given Project footprint.
Duration	Future	The effect to ECARs is expected to last beyond the life of the Project.
Reversibility	Irreversible	Much of the ECARs affected will be lost within the TMF and thus the effects will not be reversible.
Context	Neutral	The area has been moderately disturbed by previous human development.
Level of Confidence	Moderate	The TEM was used to identify spatial locations and abundance of ECAR in the LSA. Spatial accuracy of the TEM is moderate given the scale.

Potential Project effects to wetlands were analysed spatially. Loss of wetlands in the proposed Project facilities footprint was the main effect to wetlands. Two general footprints were used: one to represent the area affected during Construction, and one to represent the additional area affected during Operations. Outside of these footprints, but within the LSA, it was assumed that loss of wetlands would not occur (Figure 15.5-3).

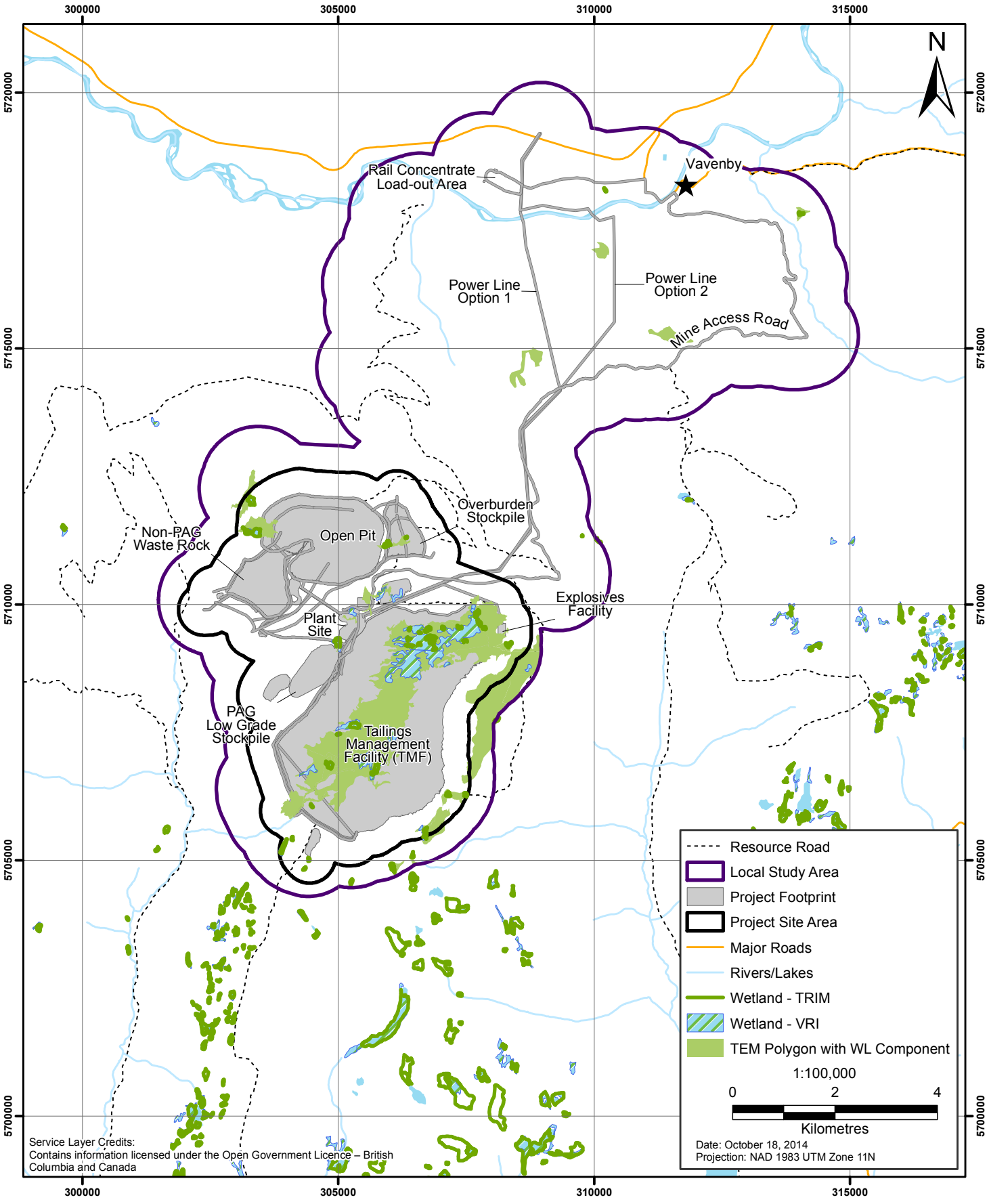
Ecosystem mapping of wetlands was used to establish the extent of the expected residual effects. Eight wetland site series were identified and distributed amongst five of the BGC variants within the LSA (Table 15.5-13). The majority of wetlands (96%) within the LSA were located at higher elevations, within the ESSF variants. Many of these wetlands are located in the TMF footprint (Figure 15.5-3).

Table 15.5-13. Areas of Wetlands Mapped within the LSA

BGC variant	Common Name	Site Series	Area (ha) in LSA	Area (ha) Altered	Area Lost (ha) in Footprints	% Lost
ESSFwc2	Water sedge / peat-moss	Wf03	122.4	7.5 (4%)	106.4	87 %
	Barclay's willow / water sedge / glow moss	Wf04	33.9		33.5	99 %
	Tufted clubrush / star moss*	Wf11	3.4		3.4	100%
ESSFwcp	Water sedge / peat-moss	Wf03	2.8		0	0 %
ESSFwcw	Narrow-leaved cotton-grass / marsh-marigold	Wf12	1.6		0	0 %
	Narrow-leaved cotton-grass / shore sedge	Wf13	33.5		0	0 %
ICHmw3	Mountain alder / pink spirea / sitka sedge	Ws02	3.2		0	0 %
	Drummond's willow / beaked sedge	Ws04	2.8		0	0 %
IDFmw2	Mountain alder / skunk cabbage / lady fern	Ws01	1.0		0	0 %
	Mountain alder / pink spirea / sitka sedge	Ws02	1.3		0	0 %
Total			**205.8**	**7.5**	**143.3**	**70 %**

**Tufted clubrush / star moss (Wf11) is also an ECAR*

Figure 15.5-3
Wetlands in the Local Study Area



Alteration of wetland functions was assessed quantitatively within 100 m of proposed Project footprints and 7.5 ha of Wf03 will be altered (Figure 15.5-3). Project activities may result in alteration of wetland functions adjacent to Project footprints. Fugitive dust is possible within 100 m of wetlands edges and can change biochemical, ecological, and habitat functions (Dale and Freedman 1982) (Eller 1977; McCune 1991; Walker and Everett 1991; Farmer 1993b; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines 1998; Anthony 2001).

Seepage, potentially containing elevated metal levels including selenium, has the potential to impact fish and wildlife that feed in wetlands. Selenium levels have been predicted by modeling to be above the water quality guidelines (WQG) value of 2 micro-g/L (Nagpal and Howell 2001) at certain locations downstream of mine faculties sporadically during Operations. Wetlands with elevated selenium levels may provide reducing conditions that favour the formation of organo-selenium compounds. These have been shown to bioaccumulate in fish and waterfowl from dietary sources (USEPA 1998); however, effects on vegetation are less of a concern. Bioaccumulation of selenium in fish and wildlife is addressed in Chapters 14 and 16, respectively, and has been addressed through development of a Selenium Managment Plan (Chapter 24).

Changes to hydrology are also possible as surface and subsurface hydrology patterns are altered, and these can alter the timing and quantity of water entering wetlands and can influence the functions that wetlands provide (Mitsch and Gosselink 2000). Alterations to wetland functions will continue to occur as new hydrological regimes in affected wetlands become established. Possible changes to wetland functions may include alteration of habitat due to altered successional pathways, hydrodynamics, and hydrological connectivity; water quality treatment; and nutrient and organic export (Odland and del Moral 2002; Sheldon 2005).

Edge effects may result in altered microclimate conditions along wetland edges and windthrow may increase. Many of the changes associated with microclimate occur within one tree length of the dominant trees (Spittlehouse, Adams, and Winkler 2004). Most likely, the distance over which edge effects occur will be less in open (treeless) habitats such as wetlands but changes in amount of light, temperature, wind, other variables can affect wetland vegetation communities.

Characterization of Residual Effect to Wetlands - Loss

Within the LSA 70% of wetlands may be affected by vegetation clearing and other Project activities during Construction and Operations. The loss in the ESSFwc2 is considered a high-magnitude effect (Table 15.5-14). The extent of loss is local and will occur once during footprint development. Effects are expected to be long-term and partially irreversible as the reclamation will only replace 17.6 ha of lost wetlands and the TMF pond will remain after Closure.

Likelihood for Residual Effect to Wetlands - Loss

Likelihood criteria are provided in Table 15.5-8. Likelihood of residual effects to wetlands due to loss is high and 7.5 ha of Wf03 will be altered. The locations of Project footprints are known, and while TEM is somewhat inaccurate in spatially defining wetlands, residual effects are highly likely to occur.

Table 15.5-14. Residual Effects to Wetlands due to Loss

Criterion	Characterization	Explanation
Direction	Negative	There will be a decrease in wetland area.
Magnitude	High	143 ha of the wetland-meadow areas within the LSA will be removed during Project Construction and Operations phases.
Geographic Extent	Local	High wetland losses (>80%) occur only within the upland portion (ESSFwc2 variant) of the LSA.
Frequency	One time	Most wetlands affected by the Project will be affected by direct loss during footprint development. This will only occur once.
Duration	Long-term	The reduction of wetlands will last until the Project Operations are complete, at which time reclamation will restore wetlands within footprint areas.
Reversibility	Irreversible	The reduction in wetlands due to the Project is irreversible.
Context	Neutral	The LSA and associated wetlands have been disturbed and fragmented by previous human development (cattle grazing, recreation).
Level of Confidence	Low	TEM accuracy for delineating wetlands is low due to the complexes of wetlands and meadow habitat and given the scale of the mapping. Therefore the quantitative estimation of wetlands lost is likely overestimated. The success of wetland reclamation is unknown.

Characterization of Residual Effect to Wetlands - Alteration

Residual effects to wetlands due to alteration of wetland function are low magnitude and occur locally where wetlands are within 100 m of Project footprints (Table 15.5-15). The frequency is continuous but changes are incremental. After Closure and Reclamation, effects are reversible and a return to baseline conditions is possible.

Table 15.5-15. Residual Effects to Wetlands due to Alteration

Criterion	Characterization	Explanation
Direction	Negative	There will be a decrease in wetland functions.
Magnitude	Low	11.3 ha of wetland-meadow areas near footprints may be altered during Project Construction and Operations phases.
Geographic Extent	Local	Wetland alteration occurs only within 100 m of Project footprints
Frequency	Continuous	Dust inputs, alteration of hydrology will be incremental changes.
Duration	Long-term	Upon reclamation most, alteration of functions will be minimized.
Reversibility	Reversible	Alteration of wetlands due to the Project is reversible using reclamation.
Context	Neutral	The LSA and associated wetlands have been disturbed and fragmented by previous human development (cattle grazing, recreation).
Level of Confidence	Low	TEM accuracy for delineating wetlands is low due to the complexes of wetlands and meadow habitat and given the scale of the mapping. Therefore the quantitative estimation of wetlands lost is likely overestimated. The success of wetland reclamation is unknown. The exact effects of dust, hydrologic changes and other edge effects are unknown.

Likelihood for Residual Effect to Wetlands - Alteration

Likelihood criteria are provided in Table 15.5-8. Likelihood of residual effects to wetlands due to alteration is moderate. While the locations of Project footprints are known, the ability of TEM to predict and accurately spatially define wetlands is moderate as they are often mapped as partial components of polygons. As well, alteration of wetland function by edge effects, invasive species, dust, and contamination are likely but may not occur (moderate likelihood).

15.5.3.4 Old-growth Forests

Residual effects on old-growth forests are those effects predicted to remain after the application of mitigation measures. Table 15.5-6 provides a summary of mitigation measures for old-growth, effectiveness of mitigation, and the potential for a residual effect after mitigation. Residual effects to old-growth were expected for loss but not alteration. Alteration to old-growth forests is excluded from further analysis.

Potential Project effects to old-growth forests were quantified through spatial analysis. Project facilities footprints were assumed to be the area where direct effects old-growth forests are expected. Two general footprints were used: one to represent the area affected during Construction, and one to represent the additional area affected during Operations. Outside of these footprints, but within the LSA, it was assumed that loss of old-growth forests would not occur.

The effects to old-growth forests were assessed using forests identified in the VRI as greater than 140 years of age. Approximately 25% (610 ha) of old-growth forests will be affected by the Project (Figure 15.5-4). The majority of affected old-growth is at high elevations in the ESSF variants and a portion within the TMF is identified as a long-term OGMA.

Characterization of Residual Effect to Old-growth Forests – Loss

Table 15.5-16 describes the residual effects to old-growth forests using definitions specified in Table 15.5-7. Loss of old-growth forests is considered a high-magnitude effect as there is a 25% decrease from baseline values. High-elevation old-growth forests are more common than those found at low elevation (due to historic logging and natural disturbance regimes). The effect is considered local because the majority of effects are expected to occur at high elevations within the LSA. The frequency of old-growth forest loss is limited to during Construction and Operations, and vegetation clearing will occur only once in a given footprint. Extensive logging in the LSA has affected the quantity of old-growth forest. Much of the LSA is structural stages 3 (shrub) and 4 (pole/sapling). Structural stage 3 accounts for 2,374 ha and much of this type is the result of logging in the past 20 years. Structural stage 4 is 1,300 ha in the LSA, and is due to logging 20 to 40 years ago. The LSA has already been heavily disturbed and fragmented.

Likelihood for Residual Effects to Old-growth - Loss

Likelihood criteria are provided in Table 15.5-8. Likelihood of residual effects to old-growth is high. The locations of Project footprints are known and VRI accurately maps old-growth, so estimates of loss are accurate and the effect is expected to occur as predicted.

Figure 15.5-4
Old-growth Forest and Management Areas

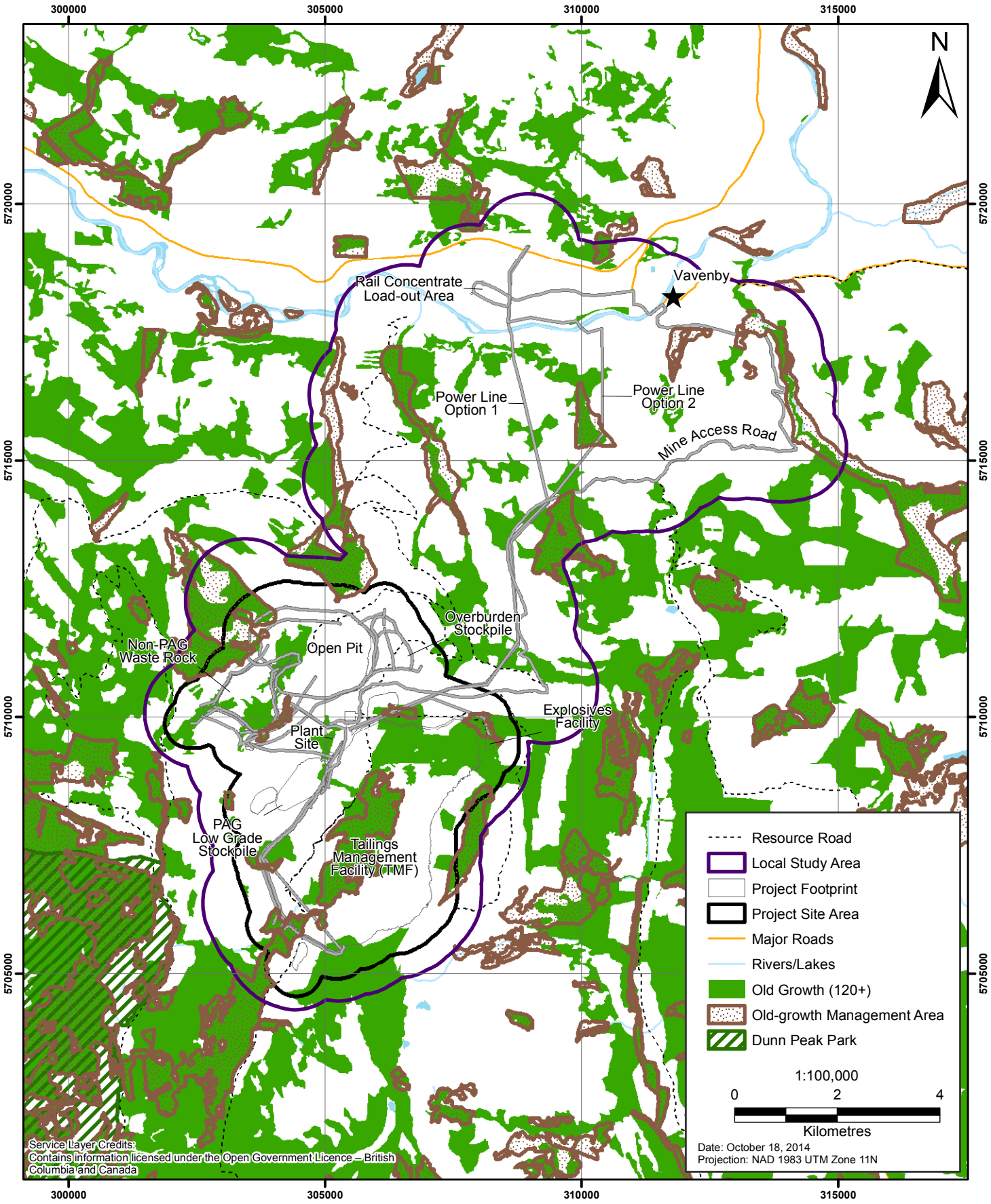


Table 15.5-16. Residual Effects to Old-growth Forests

Criterion	Characterization	Explanation
Direction	Negative	There will be a decrease in old-growth forests.
Magnitude	High	610 ha of the old-growth forests within the LSA will be removed by vegetation clearing and other habitat alterations for the Project Construction and Operations.
Geographic Extent	Local	High-elevation old-growth is generally more common than that found at low elevation, due to increased difficulty of access and less commercially-valuable forest. Most of the effect to old-growth will be at high elevations and thus is considered to be a local effect.
Frequency	One time	Removal of old-growth forests will only occur once.
Duration	Long-term	The reduction of old-growth forests will last for longer than the life of the Project.
Reversibility	Reversible	The younger forests within the LSA could grow into old-growth if left undisturbed.
Context	Neutral	The LSA has been heavily disturbed and fragmented by previous human development (forestry, cattle grazing, recreation).
Level of Confidence	High	Old-growth forests has been spatially identified and quantified using the VRI.

15.5.3.5 Summary of Residual Effects on Vegetation

All four VCs, rare plants, ECAR, wetlands, and old-growth forests, have residual effects due to loss. Only wetlands have residual losses associated with alteration. The greatest impact of the Project is vegetation clearing and stripping topsoil to clear footprints for Construction. The majority of loss of the four VCs was in the TMF (Table 15.5-17).

Table 15.5-17. Summary of Residual Effects on Vegetation

Valued Component	Project Phase (Timing of Effect)	Cause-Effect [1]	Mitigation Measure(s)	Residual Effect
Rare Plants	Construction/ Operations	**Loss** -Vegetation clearing, mine construction	Avoidance of known occurrences, regional surveys in the ESSFwc2.	Yes
		Alteration – Dust, edge effects, invasive species	Fugitive dust management, contaminants control measures, invasive plant species control, water quality and quantity measures, reclamation.	No
ECAR	Construction/ Operations	**Loss** - Vegetation clearing, mine construction	Avoidance, minimization of alteration, regional surveys.	Yes
		Alteration – Dust, edge effects, contaminants, invasive species	Windthrow management, dust management, contaminants control measures, invasive plant species control, reclamation.	No

(continued)

Table 15.5-17. Summary of Residual Effects on Vegetation (completed)

Valued Component	Project Phase (Timing of Effect)	Cause-Effect [1]	Mitigation Measure(s)	Residual Effect
Wetlands	Construction through Post-Closure	**Loss** - Vegetation clearing, mine construction	Avoidance, footprint alteration, reclamation.	Yes
		Alteration - Dust, edge effects, contaminants, invasive species	Appropriate culverts, manage edge effects, dust management, contaminants control measures, invasive plant species control, reclamation.	Yes
Old-growth Forests	Construction/ Operations	**Loss** - Vegetation clearing, mine construction	Avoidance, minimization of alteration, replacement OGMA reclamation.	Yes
		Alteration - Dust, edge effects, invasive species	Manage edge effects, dust management, contaminants control measures, invasive plant species control, reclamation.	No

[1] *"Cause-effect" refers to the relationship between the Project Component/physical activity and the VC; describe what is causing the change or effect in the condition of the VC, indicator or discipline.*

15.5.4 Significance of Residual Effects

The significance determination follows a two-step process; first the severity of residual effects is ranked according to a minor, moderate, and major scale (see Chapter 8, Plate 8.6-1). The scale is determined primarily based on the magnitude of the effect and professional judgement. The following definitions of the significance ratings are used to guide the significance ratings for Vegetation VCs:

- **Not significant (minor or moderate scale)**: Residual effects have low or moderate magnitude; local to regional geographic extent; short- or medium-term duration; could occur at any frequency, and are reversible or partially reversible in either the short or long-term. The effects on the VC (e.g., at a species or local population level) are either indistinguishable from background conditions (i.e., occur within the range of natural variation as influenced by physical, chemical, and biological processes), or distinguishable at the individual level. Land and resource management plan objectives will likely be met, but some management objectives may be impaired.
- **Significant (major scale)**: Residual effects have high magnitude; regional or beyond regional geographic extent; duration is long-term or far future; and occur at all frequencies. Residual effects on VCs are consequential (i.e., structural and functional changes in populations, communities, and ecosystems are predicted) and are irreversible. The ability to meet land and resource management plan objectives is impaired.

The four vegetation VCs may experience residual effects. Significance determinations are presented below (Sections 15.5.4.1 through 15.5.4.4).

15.5.4.1 Rare Plants

Loss of rare plants is considered high magnitude and of regional extent, specifically for Howell's quillwort, where five occurrences will be lost and only a few other occurrences have been recorded in the province. The impacts of the Project will extend into the future. The loss of rare plants is expected to be **significant** (major).

15.5.4.2 Ecological Communities at Risk

Loss of ECAR in the ESSFwc2 BGC variants will be high magnitude, including loss all of the tufted clubrush /golden star moss and a loss of 46% of the Lodgepole pine / dwarf blueberry / peat-mosses ECAR. These losses are considered to be of local extent. The impacts of the Project will extend into the future, though will occur only once during Construction and Operations for each footprint. The loss of ECAR is expected to be **significant** (major).

15.5.4.3 Wetlands

Loss of wetlands is considered high magnitude and local extent, given the majority of high-elevation wetlands within the LSA are located in Project footprints. The impacts of the Project will extend into the far-future, though they will occur only once during Construction and Operations for each footprint. Reclamation may reduce the total wetlands lost; however, the success of wetland creation at high elevations is unknown. The loss of wetlands is expected to be **significant** (major).

Alteration of wetland function was considered moderate magnitude. There is a limited extent of alteration anticipated (only areas within 100 m of project footprints) and the effects are reversible after Closure when cessation of project activities occurs and reclamation is implemented. Alteration of wetlands is expected to be **not significant** (minor).

15.5.4.4 Old-growth Forests

Loss of old-growth forests is considered of high magnitude and of local extent. The majority of old-growth forest in the RSA is located at high elevations, some of which will be impacted by the Project; however, high-elevation old-growth forests are generally more common than old-growth found at low elevation. The impacts to old-growth will extend into the future, though they occur only once per footprint. If younger structural stage forests are left undisturbed they will eventually become old-growth forests. Loss of old-growth forest is expected to be **not significant** (moderate).

15.5.5 Confidence and Uncertainty in Determination of Significance

Confidence, which can also be understood as the level of uncertainty associated with the assessment, is a measure of how well residual effects are understood and the confidence associated with the baseline data, modelling techniques used, assumptions made, effectiveness of mitigation, and resulting predictions.

Confidence is based on an evaluation of the scientific certainty in the review of Project specific data, relevant literature, and professional opinion. Definitions of the confidence classes can be found in Table 15.5.18. Confidence in the significance of effects for the four vegetation VCs is described below).

Table 15.5-18. Attributes of the Confidence in the Significance or Likelihood of the Effects

Class	Description
Low	The cause-effect relationships are poorly understood, there are a number of unknown external variables, and data for the Project Site are incomplete. The effectiveness of the mitigation measures may not yet be proven. High degree of uncertainty and final results may vary considerably.
Moderate	The cause-effect relationships are not fully understood, there are a number of unknown external variables, or data for the Project Site are incomplete. The effectiveness of mitigation measures are moderately well understood. There is a moderate degree of uncertainty; while results may vary, predictions are relatively confident.
High	There is a good understanding of the cause-effect relationship and all necessary data are available for the Project Site. The effectiveness of the mitigation measures is well known. There is a low degree of uncertainty, and variation from the predicted effect is expected to be low.

Although general predictions of adverse rare plant effects are sound, the specific disturbance responses for the rare plants in the LSA are unknown, and distribution data within BC is incomplete for many of the affected rare plant taxa. The level of confidence for residual effects assessment of rare plants is **low**.

The spatial accuracy of TEM used to identify spatial locations and abundance of ECAR in the LSA is moderate. There is great uncertainty in the ability to predict locations of ECAR on the regional landscape. It is expected that the current amount of ECAR predicted in the LSA is an over estimate of its occurrence. Consequently, the level of confidence for ECAR is considered **moderate**.

TEM accuracy for delineating wetlands is moderate due to the complexing of wetlands with meadow habitat. Therefore the quantitative estimation of wetlands lost is likely higher than actual loss estimate. The success of wetland reclamation at high elevations is also unknown. The level of confidence for the residual effects assessment of wetlands is **low** because of this uncertainty.

VRI accuracy for delineating old-growth forests is high. The level of confidence for the residual effects assessment of old-growth forest is **high**.

15.5.6 Summary of the Assessment of Residual Effects for Vegetation

Table 15.5-19 provides a summary of residual effects, mitigation measures, and significance determinations for the residual effects for the four vegetation VCs identified throughout Section 15.5.

15.6 CUMULATIVE EFFECTS ASSESSMENT

The cumulative effects assessment (CEA) considers the effects on vegetation VCs that are likely to result from the residual environmental effects of the Harper Creek Mining Project in combination with the effects of other projects and activities that have been or are likely to be carried out in the same area as the Project. The CEA methodology is based on the framework outlined by the *Canadian Environmental Assessment Act* (1992) guidelines (Hegmann, Cocklin, Creasy, et al. 1999) with additional guidance provided in the AIR. The following steps are taken in this CEA:

Table 15.5-19. Summary of Key Effects, Mitigation, Residual Effects Characterization Criteria, Likelihood, Significance, and Confidence

Key Effect	Mitigation Measures	Summary of Residual Effects Characterization Criteria *(Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Resiliency)*	Likelihood *(High, Moderate, Low)*	Significance of Adverse Residual Effects		Confidence *(High, Moderate, Low)*
				Scale (*Minor, Moderate, Major*)	Rating *(Not Significant; Significant)*	
Loss of Rare Plants	Avoidance of known occurrences,	A high magnitude proportion of rare plant occurrences in the LSA are expected to be lost as a result of the Project. The loss is irreversible and permanent. The frequency of the residual effects is low. Vegetation clearing and alteration will only occur once per footprint. The greatest effect of the Project is the loss of the Red-listed and S1 (Critically imperiled) rare plant, Howell's quillwort. There are only a few known occurrences within the province. Clearing of vegetation is expected to remove all five known occurrences in the LSA and have regional consequences.	High	Major	Significant	Low
Loss of ECAR	Avoidance, minimization of habitat alteration, reclamation	Approximately 11 % of all ECAR mapped in the LSA will be lost/removed as a result of Project Construction and Operations including 3.4 ha of the tufted clubrush / golden star moss and 46% of the Lodgepole pine / dwarf blueberry / peat-mosses ECAR. The majority of ECARs will be lost as a result of the TMF, and will not be reversible through reclamation or time; however, some areas may return to previous conditions. Those ECAR that will be lost are restricted to a few localized areas within the LSA, and the effects of alteration will only occur once per footprint.	Moderate	Major	Significant	Moderate
Loss of Wetlands	Avoidance, footprint alteration, reclamation,	Seventy percent of wetlands found within the LSA may be affected by Project activities, which is considered a high magnitude effect. Reclamation efforts will be made to restore/replace lost wetlands within the Project Site where possible and establishing and developing wetlands outside of the LSA is also being considered to help mitigate this loss. However, reclamation will occur during Closure and Post-Closure, therefore the impact of the loss of wetlands is expected to be long-term	High	Major	Significant	Low

(continued)

Table 15.5-19. Summary of Key Effects, Mitigation, Residual Effects Characterization Criteria, Likelihood, Significance, and Confidence (completed)

Key Effect	Mitigation Measures	Summary of Residual Effects Characterization Criteria *(Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Resiliency)*	Likelihood *(High, Moderate, Low)*	Significance of Adverse Residual Effects		Confidence *(High, Moderate, Low)*
				Scale (*Minor, Moderate, Major*)	Rating *(Not Significant; Significant)*	
Alteration of Wetlands	Appropriate culverts, manage edge effects, dust management, contaminants control measures, invasive plant species control, reclamation	Alteration of wetland function will occur where wetlands intersect Project footprints (4% of wetlands). Changes to hydrological functions, biochemical functions, ecological functions, and wetland functional diversity are likely to occur. Mitigation will reduce the amount of alteration experiences by wetlands and most effects should be limited to less than 100 m from Project footprints. Alteration of wetlands is likely to occur to wetlands within 100 m of the pit and TMF.	Moderate	Minor	Not Significant	Low
Loss of Old-growth forests	Avoidance, minimization of alteration. reclamation	Approximately 25 % of old-growth forests will be affected by the Project. This is considered a high-magnitude effect. High-elevation old-growth is generally more common than that found at low elevation. The effect is considered local because the majority of loss is expected to occur at high elevations, the frequency of removal is limited to vegetation clearing during Construction and Operations, and the duration is only once in a given footprint. Extensive logging in the LSA has greatly affected the quantity of old-growth forests historically. Therefore the LSA has already been heavily disturbed and fragmented.	High	Moderate	Not Significant	High

The method involves the following key steps which are further discussed in the following sub-sections:

- scoping;
- analysis;
- identification of mitigation measures;
- identification of residual cumulative effects; and
- determination of significance.

15.6.1 Scoping Cumulative Effects

The scoping process involves identification of the receptor VCs for which residual effects are predicted, definition of the spatio-temporal boundaries of the assessment, and an examination of the relationship between the residual effects of the Project and those of other projects and activities.

15.6.1.1 Valued Components and Project-related Residual Effects

Receptor VCs included in the CEA were selected according to the methodology described in Section 8.7. Four VCs are identified as having residual effects as a result of the Project, as summarized in Table 15.6-1. The residual effects marked with a "Y" in Table 16.7-1 were carried forward into the CEA, where other projects that may interact with these effects for VCs on a larger spatial scale are considered.

Table 15.6-1. Residual Effects Predicted from the Vegetation Application/EIS

VC	Loss	Alteration
Rare Plants	**Y**	N
ECAR	Y	N
Wetlands	Y	Y
Old-growth	**Y**	N

Note: All effects are identified as begin during the Construction phase and continuing into Post-closure. The presence of a residual effect is marked with a "Y" while those effects not expected to result in a residual effect are marked with an "N." All residual effects (marked with a "Y") are considered in this CEA.

<u>Rare Plants</u>

The primary effect of the Project on rare plants will be direct loss of rare plant occurrences during development of Project footprints. Reclamation can provide opportunities for rare plants to recolonize over time but this is dependent on the success of re-vegetation efforts and invasive species management. The residual effects of the Project to rare plants were significant with low confidence.

Ecological Communities at Risk

The primary effect of the Project on ECAR will be the direct loss of ECAR. Reclamation can provide opportunities for some of these communities to re-establish themselves over time but this could be dependent on the success of re-vegetation efforts and invasive species management. Losses of ECAR will only occur once within any given footprint and will be restricted to a few localized areas within the LSA. The residual effects of the Project to the two ECARs in the ESSF variant were significant with moderate confidence.

Wetlands

The Project is expected to have a significant residual effect to wetlands due to the loss of about 143 ha of existing wetlands in the LSA and alteration of 7.5 ha within 100 m of project footprints. Reclamation will aim to re-establish some of the disturbed wetland areas (see Chapter 7, Closure and Reclamation, for details). It will provide opportunities for these communities to re-establish themselves over time, but this could be dependent on the success of re-vegetation efforts, water quality, and invasive species management. The effect of the Project on wetland loss is considered significant. The residual effects on wetlands due to alteration were considered not significant.

Old-growth Forests

The primary effect of the Project on old-growth forests will be loss of old-growth forests within the Project Site footprint. Reclamation can provide opportunities for some of these communities to re-establish themselves over time and current young forests in the area will continue to develop into old-growth if left untouched. The residual effects of the Project to old-growth forests were not significant.

15.6.1.2 Defining Assessment Boundaries

Similar to the Project-related effects, assessment boundaries define the maximum limit within which the cumulative effects assessment (CEA) is conducted. Boundaries relevant to vegetation are described below.

Temporal boundaries for cumulative effects consider three time periods and scenarios. Time periods consider past, present, and future conditions. The scenarios include:

- **past:** no longer operational projects and activities that were implemented in the past 50 years. This temporal boundary enables to take into account any far-future effects from past projects and activities;
- **present:** active and inactive projects and activities; and
- **future:** certain projects and activities that will proceed and reasonably foreseeable projects and activities that are likely to occur. These projects are restricted to those that 1) have been publicly announced with a defined project execution period and with sufficient project details for assessment; and/or 2) are currently undergoing an environmental assessment; and/or 3) are in a permitting process.

Reasonably foreseeable projects include activities that have been identified, but may or may not proceed (Hegmann, Cocklin, Creasey, et al. 1999). The amount of information available about these projects and activities can vary significantly, and the inclusion of these activities in the CEA process depends on the amount and quality of the information available. The projects and activities considered in the CEA are described in Chapter 8, Section 8.7.1.3.

The CEA area for this assessment is the RSA shown in Figure 15.6-1, which consists of the Vavenby and Barriere LUs, as described in 15.3.2.2. This area encompasses the Project, the LSA, and a broader surrounding area where there is potential for interaction of the Project with past, present, and future activities that might result in cumulative adverse effects on vegetation. The RSA is 150,010 ha in size.

15.6.1.3 Projects and Activities Considered

Past, present, and reasonably foreseeable future projects and activities within the boundaries described above were considered in the CEA. The project list was developed from a wide variety of information sources, including municipal, regional, provincial, and federal government agencies; other stakeholders; and companies and businesses websites. The projects and activities considered in the CEA are presented in Chapter 8, Assessment Methodology, in Tables 8.7-1 and 8.7-2, respectively. The methodology used in the CEA is provided in Chapter 8, Section 8.7.

All Project-related residual effects were considered for their potential to interact with the projects and activities identified within the CEA area. A map indicating the location of past, present, and reasonably foreseeable future projects and activities within the RSA is provided in Figure 15.6-1.

Human Activity

Aboriginal Harvesting

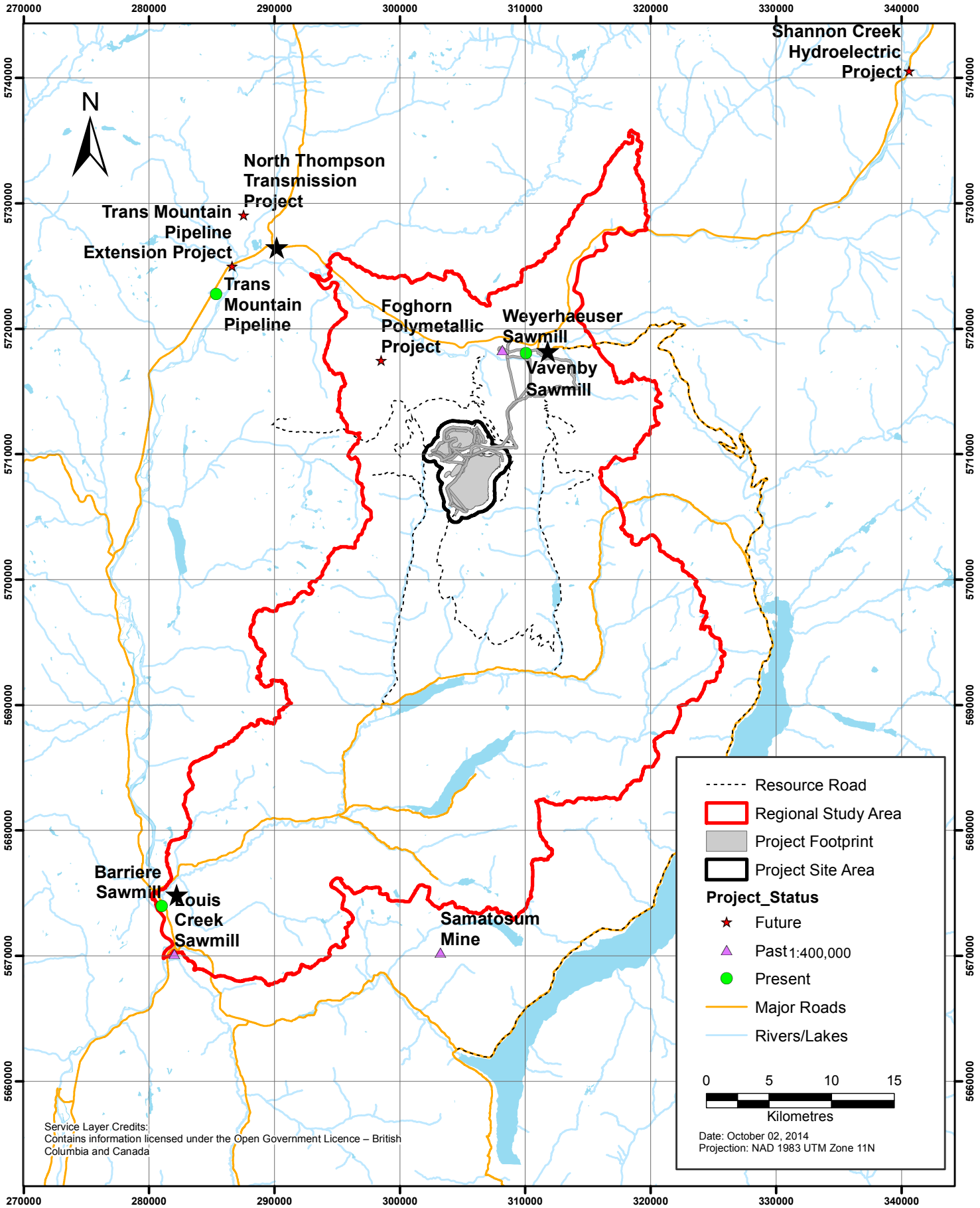
Aboriginal hunting, trapping, fishing, and gathering all occur within the CEA area.

Hunting/Trapping/Fishing

The Project RSA lies within "Region 3 – Thompson" of the Hunting and Trapping Regulations Synopsis; four Management Unit (MU) boundaries (3-37, 3-38, 3-41 and 3-42) divide up the RSA (BC MFLNRO 2012). The hunting of ungulates, furbearers, large carnivores, waterfowl, and game birds takes place throughout the RSA; moose and mountain sheep are hunted in September and October; white-tailed deer and mule deer are hunted from September to December; cougar, bobcat, lynx, black bear, wolf, and coyote seasons take place in varying months throughout the year; racoon have no closed season; various game birds and waterfowl are typically hunted between September and December(BC MFLNRO 2012). A variety of hunting clubs and guide-outfitter businesses also exist in the area, with hunting taking place during most months of the year (North Thompson Food Action Network 2010a, 2010b).

The Thompson-Nicola region is an important area for freshwater sport fishing, particularly of rainbow trout. There are seven lakes in the CEA area used for non-commercial fishing and one guided freshwater fishing licence tenure within the CEA.

Figure 15.6-1
Location of Past, Present and Reasonably Foreseeable Future Projects for the Cumulative Effects Assessment for Vegetation



Dunn Peak Protected Area

The Dunn Peak Protected Area is a park that was created on April 30, 1996 as a result of recommendations made in the Kamloops LRMP (Kamloops Interagency Management Committee 1995). It is a large wilderness area noted for important wildlife habitat, backcountry recreation opportunities, and mountain scenery. It is 19,353 ha and extends from the North Thompson River in the west, including the alpine areas of Dunn Peak, to the bottom of Harper Creek in the Shuswap Highlands in the east (BC Parks 2012).

No aircraft access is permitted in the park and there are no roads in the park. Important habitats for a large variety of wildlife populations, including wolf, cougar, marten, river otter, black bear, mule deer and mountain goat, Great Blue Heron, and Bald Eagle are protected(BC Parks 2012).

On the east side of Dunn Peak there is a user-created trail located above Harper Creek. The addition of a boardwalk and other recent trail work has improved hiking conditions. Snowshoeing and backcountry and alpine ski touring opportunities also exist on Dunn Peak (BC Parks 2012).

Snowmobiling

The North Thompson Valley provides a number of snowmobiling opportunities within the RSA. The season is variable, depending on snowpack and seasonal temperatures, but average months of operation are November to April. There are a variety of companies that run tours in the North Thompson Valley, including along Harper Creek. This area attracts snowmobilers with its views of Clearwater from Granite and Foghorn Mountains as well as its view of Dunn Peak, and may be accessed via the Harper Creek Forest Service Road. A shelter exists on Foghorn Mountain that is maintained by the Clearwater Sno-Drifters Snowmobile Club (NTValley.com ; Kamloops Snowmobile Association 2007; The District of Clearwater 2012; Tourism Kamloops 2012).

Settlements

Vavenby

The unincorporated Community of Vavenby is located approximately 25 km southeast of Clearwater. Forestry is the primary industry in Vavenby, with a large portion of its approximately 700 residents employed or affiliated with Canfor and/or the forest industry either by working in the mill, contract logging, or in the trucking industry (NTValley.com ; British Columbia Travel and Discovery 2012).

Recreation in Vavenby consists mainly of outdoor activities, such as snowmobiling, tobogganing on old logging roads, horseback riding, hiking, fishing, and camping (British Columbia Travel and Discovery 2012).

Birch Island

Birch Island is located approximately 10 km southeast of Clearwater. Historically, it was one of the largest communities on the northern stretch of the Southern Yellowhead Highway (Highway 5), housing a railway station and hotel. Today, Birch Island is a small farming and logging community, with the majority of residents commuting to Clearwater and Vavenby for work (Tourism Wells Gray 2010).

Barriere

Settled in the early 1800s, the community of Barriere is located 66 km north of Kamloops on Highway 5. It is located in the central North Thompson Valley, surrounded by the Barrière and North Thompson rivers (NTValley.com ; iCompass Technologies Inc 2009), and falls just within the RSA.

Forestry, tourism, and agriculture are the main industries of the approximate 3,450 residents of Barriere. Winter and summer recreation activities are commonplace in and around the Barriere area (NTValley.com ; Shangaan Webservices Inc 1998; iCompass Technologies Inc 2009).

Transportation

The Canadian National Railway passes through the North Thompson Valley. The Yellowhead Highway (Highway 16) runs from BC to Manitoba, and serves as an alternate to the Trans-Canada Highway (Highway 1). Highway 5 is separated into two parts: the southern portion from Kamloops to Hope is referred to as Coquihalla Highway, while its northern portion is known as the Southern Yellowhead Highway (Highway 5).

Commercial or Industrial

Farming/Grazing

Both sheep and cattle graze within the RSA, with flocks and herds grazing on rangeland and alpine flower meadows from spring to fall. Some ranches also offer trail rides in and around the Project RSA (Kamloops and Clearwater Forest Districts 2001; Aveley Ranch 2012; The Shook Ranch 2012).

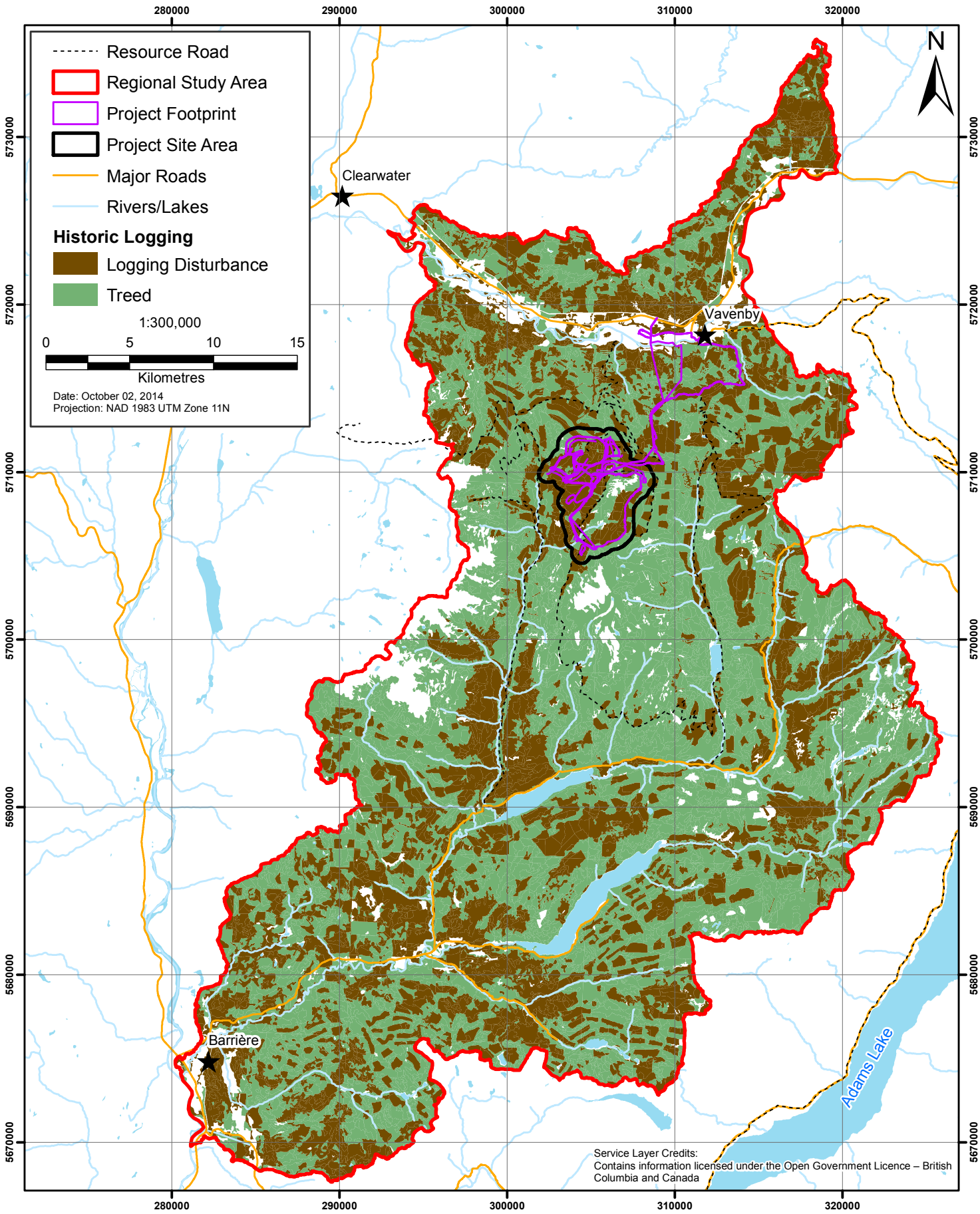
Forestry

The largest industry in the area is forestry. The Kamloops Timber Supply Area (TSA) includes the Kamloops and Headwater Forest Districts and is 2.77 million ha including Wells Gray provincial Park. Of this area about 950,000 ha is part of the timber harvesting land base which consists of 30% pine, 33% Douglas-fir, 18% spruce, and 9% true fir forests. In 2000, forest tenure holders in the Kamloops TSA worked with a group of public and First Nations representatives to develop a Sustainable Forest Management Plan. This plan details the environmental, economic, and social aspects of forest management in the Kamloops - North Thompson region. The Defined Forest Area is located north of Kamloops near the North Thompson River. Currently, Canfor holds the licenses granting them the right to harvest an annual allowable cut of Crown timber. The current annual allowable cut for the Kamloops TSA is 4,000,000 m^3.

Within the RSA, 56,443 ha have been logged since the forest industry began operations in the area, according to recent VRI. This accounts for 37.6% of the RSA (Figure 15.6-2). Approximately half of the logging to date occurred prior to 1960.

Figure 15.6-2

Cumulative Logging Disturbance Pre-1960 to Present for Vegetation



A summary of sawmills within the RSA is provided below.

- The Weyerhaeuser Sawmill was closed in 2003 and acquired by Harper Creek Mining Corp. in 2011; the property, located 2.5 km west of Vavenby, is approximately 79.3 ha and has an approximate 1,880-m rail siding, connecting to the Canadian National Railway's transcontinental main line that passes through Vavenby. The property will be home to rail load-out operations associated with the Project, as well as concentrate storage and administration.
- In August 2003, the Tolko Louis Creek Sawmill operation was completely destroyed by a forest fire that began near McClure, BC; the sawmill had approximately 200 direct employees and 150 indirect employees. Tolko Industries chose not to rebuild the sawmill and associated facilities due to a lack of rail access and natural gas, but rather chose to expand production at a different location.
- The Canfor Vavenby Sawmill is a forestry processing facility located in Vavenby. The sawmill was closed in 2009 due to poor market conditions, but reopened in September of 2011 after the completion of a $24 million upgrade. Approximately 13% of the annual allowable cut in the Kamloops TSA belongs to the Vavenby Sawmill, with Canfor purchasing an additional 200,000 m^3 of timber volume to meet the needs of the mill.
- The Gilbert Smith Forest Products Barriere Sawmill has been in operations since 1968. It is a cedar sawmill that produces and sells lumber, shavings, sawdust and chips. The sawmill is situated within the town site of Barriere, adjacent to Highway 5.

Key Projects

Trans Mountain Pipeline

The Kinder Morgan Trans Mountain Pipeline is a 1,150-km-long high-pressure pipeline system that has been in operation since 1953. The pipeline moves crude oil and refined products from Edmonton, Alberta to marketing terminals and refineries in the central British Columbia region, the Greater Vancouver area and other various American markets. The Kamloops Terminal receives refined products from Edmonton and routes them to Kamloops for local distribution. Kamloops is also a receiving site for products from northeastern British Columbia that are bound for the west coast. The site contains two storage tanks with an overall volume of 23,000 m^3 (144,000 bbl). The initial pump capacity was 150,000 bbl/day with four pump stations along the pipeline and a marine loading dock; today the capacity of the system has doubled to 300,000 bbl/day. This pipeline crosses many Aboriginal territories and is located on both public and private lands as it follows the same general pathway as Highway 5.

In 2012, Kinder Morgan proposed to expand the Trans Mountain Pipeline by twinning the existing pipeline (approximately 900 km within the existing right-of-way, where possible), adding thirteen new pump stations along the route, increasing the number of storage tanks at three existing facilities and expanding Westridge Marine Terminal. This proposed new line would transport heavier oils, while the existing line would carry refined products, synthetic crude oils and light crude oils. This pipeline expansion would increase the system capacity from 300,000 bbl/day to 750,000 bbl/day, and has an estimated cost of $4.3 billion.

This project filed an environmental assessment application in late 2013. If the application is successful, construction would be set to begin in 2016, with operations commencing in 2017.

Foghorn Project

The Foghorn Polymetallic Project consists of 3,129 ha of mineral claims in the Kamloops mining division (approximately 130 km north of Kamloops); the claims are contained in 40 parcels of Crown Granted Titles owned by International Ranger Corp. The "Rexspar" Deposit was first discovered to have fluorite in 1918; in 1926 Smuggler Hill Development Company explored a lead/silver deposit; a uranium deposit was discovered first in 1949. Extensive drilling occurred on the property between 1943 and 1976. Public resistance to the project led to a moratorium on uranium exploration; however, the Government of British Columbia lifted this ban in 1987. International Ranger intends to expand the known mineralized zones and to establish new areas of mineralization on the property; however, currently no exploration has been conducted by International Ranger Resources Inc. Future exploration will examine the viability of mining multiple commodities such as fluorite, celestite, rare earth metals, and molybdenum.

North Thompson Transmission Project

In an effort to increase power supply to the North Thompson region, BC Hydro is proposing a 230-kilovolt (kV) single-circuit overhead transmission line approximately 70 to 100 km long. There are two alternatives being evaluated: Alternative 1, which would be constructed between One Hundred Mile House and Clearwater; and Alternative 2, which would be constructed between Vavenby and a new substation to be located near the Seymour Arm. Only Alternative 2 enters the Project RSA, and therefore will be the only Alternative referred to in relation to the Project.

15.6.2 Screening and Analyzing Cumulative Effects

All past, present and reasonably foreseeable future projects located within the RSA were included in the impact matrix for screening and ranking of potential cumulative effects. A ranking of low to no, moderate, and high risk of adverse cumulative effect was calculated for each VC that was found to have a residual effect. Rankings were based on a combination of proximity of the project and activity to effected areas and professional judgement. Those projects/activities that were given a score of moderate or major adverse effect are justified below. Due to the lack of information to clearly identify effects due to alteration and loss separately in the cumulative effects assessment, these were assessed together and are denoted as loss/alteration for all VCs.

15.6.2.1 Past Projects

The old Weyerhaesuer Sawmill site will become the home to a rail load-out facility associated with the Project, as well as consist of concentrate storage and administration buildings. No data is available on the past impacts of this project on ECAR, rare plant occurrences, wetlands or old-growth forests. Similarly, there is no available information about the impacts of Louis Creek Sawmill on Project VCs. There are several rare plant observations and ECAR within 500 m to 1 km of the Weyerhaeuser Sawmill facilities. A residual effect to the VCs may have occurred previously because of this proximity; consequently there may be a potential risk of adverse cumulative effects for ECAR and rare plants. These locations were on cliff habitats and likely not to be affected.

15.6.2.2 Present Projects

No data is available on the impacts of the Barriere and Vavenby Sawmills on the Project VCs. The Vavenby Sawmill is located within 500 m to 1 km of several rare plant observations and ECAR. A residual effect to the VCs may have occurred previously because of this proximity, which leads to the opinion that there is a potential moderate risk of adverse cumulative effects for ECAR and rare plants.

No information on residual effects to VCs as a result of the Trans Mountain Pipeline construction in 1953 is available. In 1997 an upgrade to the pipeline was not expected to have any significant residual effects. Because the pipeline follows the highway, it is unlikely that the project, as it is, has had cumulative effect on wetlands, ECAR, rare plants, and old-growth forests.

15.6.2.3 Reasonable Foreseeable Future Projects

The North Thompson Transmission Project planning is currently on hold because the industrial load in the North Thompson area has not been confirmed. At this stage it is unclear which route the Project will take and whether a residual effect is expected.

The Trans Mountain Pipeline has applied to the National Energy Board for authorization in December 2013. In this application, along the Hargreaves to Darfield Segment, rare plants were thought to have a moderate risk of residual effect. ECAR, wetlands, and old-growth forests were not expected to have a significant residual effect.

No information on the potential impacts of the Foghorn Polymetallic Project is available. Depending on the size footprints, size of TMF and mine operations, and the techniques used, the Foghorn Polymetallic Project has the potential to impact a number of VCs, but most importantly will likely impact water quality along Harper Creek. The potential effects of contaminated water quality on surrounding wetlands, old-growth forests, ECAR, and rare plants is unclear.

15.6.2.4 Activities

Forestry activities and agriculture in the RSA have both had an impact on the landscape and will likely have a risk of adverse cumulative effect on wetlands, ECAR, old-growth forests, and rare plant occurrences. Both sheep and cattle graze within the Project RSA, with flocks and herds grazing on rangeland and alpine flower meadows from spring to fall. Sheep and cattle will damage wetland edges, trample rare plant occurrences, and impact ECAR associated with wetlands. Extensive logging in the LSA has greatly affected the quantity of old-growth forests historically. Within the RSA, 56,443 ha have been logged since the forest industry began operations in the area, according to recent VRI. This accounts for 37.6% of the RSA. Forestry practices will have also had a moderate effect on ECAR and rare plants.

Table 15.6-2 presents the projects and activities with the potential to interact cumulatively with the predicted residual effects for vegetation identified in Table 15.5-6.

Table 15.6-2. Impact Matrix for Screening and Ranking Potential Cumulative Effects

Residual Effects of the Harper Creek Project on VCs	Past Projects		Present Projects			Reasonably Foreseeable Future Projects			Activities										
	Weyerhaeuser Sawmill	Louis Creek Sawmill	Trans Mountain Pipeline	Vavenby Sawmill	Barriere Sawmill	North Thompson Transmission Project	Trans Mountain Pipeline Expansion	Foghorn Project	Aboriginal Harvesting	Hunting	Trapping	Fishing	Non-commercial Recreation	Commercial Recreation	Mineral Exploration	Transportation	Agriculture	Forestry	Water Use
Rare Plants																			
Loss \ Alteration	🟡	🟢	🟢	🟡	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟢
ECAR																			
Loss \ Alteration	🟡	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟢
Wetlands																			
Loss \ Alteration	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢
Old-Growth Forests																			
Loss \ Alteration	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🟢

Notes:

🟢 = *Negligible to minor risk of adverse cumulative effect; will not be carried forward in the assessment.*

🟡 = *Moderate risk of adverse cumulative effect; will be carried forward in the assessment.*

🔴 = *Major risk of adverse cumulative effect or significant concern; will be carried forward in the assessment.*

15.6.3 Mitigation Measures

The mitigation measures that can be implemented by HCMC to minimize their contribution to the cumulative effect were identified and considered for their effectiveness according to the methodology described in Chapter 8, Section 8.7.3. Table 15.6-3 outlines how mitigation of cumulative effects was considered in the assessment.

Table 15.6-3. Proposed Mitigation Measures for Potential Cumulative Effects and their Effectiveness

VC	Potential Cumulative Effect	Proposed Mitigation Measure	Mitigation Effectiveness *(low,moderate, high,unknown)*	Cumulative Residual Effect (Y/N)
Rare Plants	Loss \ Alteration	Avoid, protect (dust control), regional surveys within the ESSFwc2.	Unknown	Y
ECAR	Loss \ Alteration	Avoid, protect (dust control), reclamation.	Unknown	Y
Wetlands	Loss \ Alteration	Reclamation, wetland creation, wetland enhancement.	Moderate	Y
Old-Growth Forests	Loss \ Alteration	Reclamation	Moderate	Y

15.6.4 Cumulative Residual Effects and Characterization

15.6.4.1 Rare Plants

Cumulative Residual Effect on Rare Plants

Ranking of potential adverse cumulative effects of past, present, and foreseeable projects on rare plants was based upon proximity of rare plant occurrences to project facilities. A conservative approach was taken as the footprints for most projects are not well defined spatially and may exceed the known or predicted footprints, and project mitigation measures are unknown.

Rare plant occurrences within 0.5 km of project footprints were considered to have a major risk of adverse cumulative effect; rare plant occurrences within 0.5-1 km of project footprints were considered to have a moderate risk of adverse cumulative effect; and rare plant occurrences greater the 1 km away from project footprints were deemed to have negligible to minor risk of adverse cumulative effect. Several rare plant occurrences were located within 0.5-1.0 km of the Weyerhaeuser Sawmill, Vavenby Sawmill, and Trans Mountain Pipeline Expansion. These projects were therefore deemed to have a moderate risk of adverse cumulative effect.

A qualitative assessment of the potential effect of activities on rare plants included such factors as: amount of RSA used for activities, frequency of use (in the case of agriculture), and projected use of the area. Forest harvesting has and will continue to alter the landscapes, directly removing established rare plant populations. Past activities have likely played a part on the current

distribution of rare plant populations, although the establishment of parks and protected areas, OGMA, and riparian set-backs offer some level of protection for populations. Similarly, grazing within the RSA, and trampling of wetland edge habitat by cattle and sheep directly removes established rare plant populations and has likely affected the current distribution of rare plant populations.

Characterization of Cumulative Residual Effects on Rare Plants

Table 15.6-4 describes the cumulative residual effects on rare plants.

Table 15.6-4. Characterization of Cumulative Residual Effects on Rare Plants

Criterion	Characterization	Explanation
Direction	Negative	A moderate adverse effect is expected for rare plants.
Magnitude	Unknown	25% of rare plant occurrences known from the LSA are expected to be extirpated or compromised as a result of Project Construction and Operations, all those rare plants that are remaining within the RSA have a moderate risk of adverse cumulative effect as a result of past, present, and foreseeable-future projects.
Geographic Extent	Regional	The greatest effect of the Project to rare plants is the loss of five Howell's quillwort occurrences in the LSA. This rare plant taxa is Red-listed and S1 (critically imperilled) in BC, and is only known from a few occurrences in the province.
Frequency	One-time / regular	The majority of Project effects to rare plants occur during Construction. These are one-time events in any given area. Harvesting has occurred sporadically on the landscape over the last century, and grazing of the area occurs regularly.
Duration	Future	Rare plant conditions within Project footprints are not expected to return to baseline beyond the life of the Project. Forestry and agriculture practices may have permanently removed rare plant occurrences.
Reversibility	Irreversible	Rare plant conditions would not return to baseline conditions within certain Project facilities for the life of the Project and beyond.
Context	Neutral	The area has been moderately disturbed by previous human development. Several rare plant occurrences have persisted on the landscape despite proximity to past and present projects.
Level of Confidence	Low	Although general predictions of adverse rare plant effects are sound, the specific disturbance responses for the rare plants in the RSA are unknown; distribution data within BC is incomplete for many of the affected rare plant taxa

Likelihood of an Adverse Cumulative Residual Effect on Rare Plants

The known occurrences of rare plants that will not be affected by the project are within 0.5-1.0 km of past, present, and foreseeable-future projects, and are considered to have a moderate likelihood of cumulative residual effect. Likelihood criteria are defined in Table 15.5-7. Very little research has

been done in the RSA on rare plants and the population of some to these plants is unknown. The likelihood of an adverse cumulative residual effect on rare plants is moderate if these are determined to be the majority of rare plant occurrences in the RSA, although further surveys for Howell's quillwort are proposed in the ESSFwc2 within the RSA to characterise this likelihood, as proposed in Section 24.17.

15.6.4.2 Ecological Communities at Risk

Cumulative Residual Effects on Ecological Communities at Risk

Ranking of potential adverse cumulative effect of past, present, and foreseeable-future projects on ECAR was based upon proximity of ECAR to project facilities. ECAR within 0.5 km of project footprints were considered to have a risk of adverse cumulative effect; ECAR within 0.5-1 km of project footprints were considered to have a moderate risk of adverse cumulative effect; and ECAR greater than 1 km away from project footprints were deemed to have negligible to minor risk of adverse cumulative effect. Several ECAR were located within 0.5-1.0 km of the Weyerhaeuser Sawmill and Vavenby Sawmill. These projects were therefore deemed to have a moderate risk of adverse cumulative effect.

A qualitative assessment of the potential effect of activities on ECAR included such factors as: amount of RSA used for activities, frequency of use (in the case of agriculture), and projected use of the area. Forest removal alters landscapes that could support ECAR and directly remove established rare ecological vegetation communities; but these disturbances may also provide opportunities for other communities to become established, albeit not for several decades. Over 56,000 ha of the RSA has been logged over the past 100 years with a large percentage at lower elevations where the majority of the rarer communities occur. Past activities have contributed to the current distribution of ECAR, although the establishment of parks and protected areas, OGMA, and riparian set-backs offer some level of protection. Similarly, grazing within the RSA and trampling of wetland edge habitat by cattle and sheep directly impact wetland ECAR and have likely played a part in the current quality of ECAR.

Characterization of Cumulative Residual Effects on Ecological Communities at Risk

Table 15.6-5 describes the cumulative residual effects on ECAR.

Likelihood of an Adverse Cumulative Residual Effect on Ecological Communities at Risk

Several past and present projects have the potential to impact ECAR in the lower elevations near the rail load-out facility; however, these ECAR are of the IDF variant, for which only a small effect (1.1%) is expected. Forestry and agriculture have influenced the current distribution ECAR, and will likely continue to influence the distribution of ECAR in the future. The amount of ECAR appears to be greater in low-elevation areas where forestry occurred in the last century. Likelihood criteria are defined in Table 15.5-7. The likelihood of an adverse cumulative effect on an ESSF variant of ECAR is moderate.

Table 15.6-5. Characterization of Cumulative Residual Effects on Ecological Communities at Risk

Criterion	Characterization	Explanation
Direction	Negative	There will be a loss of ECARs within the RSA.
Magnitude	Medium	The greatest effect to ECAR will be the loss of 3.4ha of the tufted clubrush / golden star-moss ECAR within the LSA. Several ECAR within the RSA have a moderate risk of adverse cumulative effect as a result of past, present, and foreseeable-future projects.
Geographic Extent	Local	ECAR effects are restricted to a few localized areas within the RSA.
Frequency	One-time / regular	Loss of ECARs will only occur once within any given Project footprint. Forestry has occurred on the landscape over the last century, and grazing of the area occurs regularly.
Duration	Future	The effect to ECARs is expected to last beyond the life of the Project. Agriculture practices have also permanently removed ECAR.
Reversibility	Irreversible	Much of the ECARs affected will be lost within the TMF and thus the effects will not be reversible through reclamation or time.
Context	Neutral	The area has been moderately disturbed by previous human development. Majority of ECAR occur where logging occurred in the last 100 years.
Level of Confidence	Moderate	The TEM was used to identify spatial locations and abundance of ECAR in the LSA. Spatial accuracy of the TEM is moderate given the scale. Majority of RSA has no TEM.

15.6.4.3 Wetlands

Cumulative Residual Effects on Wetlands

A qualitative assessment of the potential effect of activities on wetlands included such factors as: amount of RSA used for activities, frequency of use (in the case of agriculture), and projected use of the area. Forest removal alters landscapes that could support wetlands. The establishment of parks and protected areas, and riparian set-backs offer some level of protection for wetlands. Similarly, grazing within the RSA, and trampling of wetland edge habitat by cattle and sheep can directly impact established wetlands and have likely played a part in the current quality and function of wetlands.

Characterization of Cumulative Residual Effects on Wetlands

Table 15.6-6 describes the cumulative residual effects on wetlands.

Likelihood of an Adverse Cumulative Residual Effect on Wetlands

Reclamation will provide opportunities for wetland communities to re-establish themselves over time, but will be dependent on the success of re-vegetation efforts and invasive species management. The effect of the Project on wetlands at a local scale is considered to be significant and unavoidable. Project construction will remove approximately 8% of wetlands within the RSA, and

further effects from past, present and reasonably foreseeable future Projects is likely. Based on the criteria defined in Table 15.5-7, there is a high likelihood of an adverse cumulative effect to wetlands.

Table 15.6-6. Characterization of Cumulative Residual Effects on Wetlands

Criterion	Characterization	Explanation
Direction	Negative	There will be a decrease in wetland area within the LSA.
Magnitude	Medium	More than 8% of the wetland areas within the RSA will be lost by vegetation clearing and alteration during Project Construction and Operations. The current amount available in the RSA is likely already reduced as a result of human settlements, forestry, and agriculture. Other projects are not expected to affect wetlands.
Geographic Extent	Local	Much of the wetlands in the LSA will be affected, although reclamation will aim to replace lost wetlands as much as possible. Additional low-elevation wetlands in the RSA are not expected to be impacted by past, present, and foreseeable future projects.
Frequency	One time	Most wetlands affected by the Project will be affected by direct loss during footprint development. This will only occur once.
Duration	Medium-term	The reduction of wetlands will last until the Project Operations are complete, at which time reclamation will restore 17.6 ha of wetlands within footprint areas.
Reversibility	Partially reversible	The reduction in wetlands due to the Project is partially reversible using reclamation, reestablishment and development of areas in the LSA.
Context	Neutral	The LSA and associated wetlands have been disturbed and fragmented by previous human development (forestry, cattle grazing, recreation).
Level of Confidence	Low	VRI accuracy for delineating wetlands is low due to the complexing of wetlands with meadow habitat and given the scale of the mapping. Therefore the quantitative estimation of wetlands lost is likely underestimated. The success of wetland reclamation is unknown.

15.6.4.4 Old-growth Forests

Cumulative Residual Effects on Old-growth Forests

A qualitative assessment of the potential effect of activities on old-growth forests included such factors as: amount of RSA used for activities, frequency of use (in the case of agriculture), and projected use of the area. Extensive logging in the LSA has greatly affected the quantity of old-growth forests historically. Over 56,000 ha of the RSA have been logged within the past 100 years with a good percentage at lower elevations. The establishment of parks and protected areas, OGMA, and riparian set-backs offer some level of protection for old-growth forests. Reclamation can provide opportunities for some of these communities to re-establish themselves over time and current young forests in the area will continue to develop into old-growth if left untouched.

Characterization of Cumulative Residual Effects on Old-growth Forests

Table 15.6-7 describes the cumulative residual effects on old-growth forests.

Table 15.6-7. Characterization of Cumulative Residual Effects on Old-growth Forests

Criterion	Characterization	Explanation
Direction	Negative	There will be a decrease in old-growth forests.
Magnitude	Low	Though more than 615 ha of the old-growth forests within the LSA will be lost by vegetation clearing for the Project Construction and Operations, over 56,000 ha of the RSA have been logged within the past 100 years.
Geographic Extent	Local	High-elevation old-growth is generally more common than that found at low elevation, due to increased difficulty of access and less commercially-valuable forest. Most of the effect of the Project to old-growth will be at high elevations and thus is considered to be a local effect. Previous forestry practices have removed a large portion of old-growth within the RSA.
Frequency	Sporadic	Removal of old-growth forests will only occur once as a result of Project Construction and Operations. However, harvesting has occurred throughout the RSA over the last century.
Duration	Long-term	The reduction of old-growth will last for longer than the life of the Project in some footprints. A large proportion of the RSA is forest in structural stage 3 or 4, with time, these forest will become old-growth.
Reversibility	Reversible	The younger forests within the RSA will eventually grow into old-growth if left undisturbed
Context	Neutral	The RSA has been heavily disturbed and fragmented by previous human development (forestry, cattle grazing, agriculture and recreation).
Level of Confidence	High	Old-growth has been spatially identified and quantified using the VRI.

Likelihood of an Adverse Cumulative Residual Effect on Old-growth Forests

Project Construction and Operations will impact approximately 798.6 ha of old-growth forests, the majority of which is higher elevation. This constitutes less than 2% of the old-growth forests in the RSA. Over the last century forest harvesting of old-growth forests has removed approximately 56,000 ha of old-growth forests in the RSA, the majority of which was in lower elevations. The likelihood of an adverse cumulative residual effect on old-growth forests is low.

15.6.4.5 Summary of Cumulative Residual Effects on Vegetation

Table 15.6-8 describes the cumulative residual effects on vegetation VCs.

Table 15.6-8. Summary of Cumulative Residual Effects on Vegetation Valued Components

	Cause-Effect [1]	Mitigation Measure(s)	Cumulative Residual Effect
Rare Plants			
Loss / Alteration	Past, Present, and Foreseeable-future Projects, Forestry and Agriculture	Regional Howell's Quillwort surveys.	Y
ECAR			
Loss / Alteration	Past, Present, and Foreseeable-future Projects, Forestry and Agriculture	Re-vegetation	Y
Wetlands			
Loss / Alteration	Forestry and Agriculture	Wetland creation/ enhancement within LSA.	Y
Old-growth Forests			
Loss / Alteration	Forestry and Agriculture	Re-vegetation	Y

[1] *"Cause-effect" refers to the relationship between the project/activity and the residual effect; describe what is causing the change or effect in the condition of the VC, indicator or discipline.*

15.6.5 Significance of Cumulative Residual Effects

15.6.5.1 Rare Plants

The effect of the Project on rare plants will be direct loss of rare plant occurrences during development of Project footprints. Reclamation of wetlands could provide opportunities for rare plants to recolonize over time but this is dependent on the success of re-vegetation efforts and invasive species management. The actual distribution and occurrence of rare plants in the RSA is poorly documented due to a lack of regional survey data.

Two sawmills, Weyehauser and Vavenby, are both located within 1 km of the known rare plant occurrences in the LSA, and may result in an adverse residual effect. Similarly, the Trans Mountain Pipeline Expansion determined that there may be a moderate residual effect to rare plants. Additional surveys for Howell's quillwort within the ESSFwc2 of the RSA will also be conducted, as it will experience the greatest impacts as a result of Project Construction. The residual effect of the Project on rare plants was significant, as have been the effects to rare plants by past activities and continuing possible effects from other projects. A better understanding of rare plant distribution and occurrence throughout the RSA, specifically Howell's quillwort, would assist to determine the relative impacts of the Projects considered in the cumulative effects assessment. Given this level of knowledge the cumulative effects to rare plants are **unknown** and a significance determination cannot be made.

15.6.5.2 Ecological Communities at Risk

The primary effect of the Project on ECAR identified in the LSA will be the direct loss of 100% (3.4 ha) of the tufted clubrush / goldern star-moss ESSF ECAR and 46% (20.3 ha) of the lodgepole pine / dwarf blueberry / peat-mosses ESSF ECAR. Reclamation of wetlands could provide

opportunities for wetland-associated ECAR to re-establish over time, but this will be dependent on the success of re-vegetation efforts and invasive species management.

The Project had a minor effect on ECAR in the IDF variants. Two sawmills, Weyerhaeuser and Vavenby, are both located near (0.5-1.0 km) ECAR in the IDF variant, which could result in an additional small cumulative residual effect that is not expected to be significant.

The residual effect of the Project to ECAR was considered significant at the local (LSA) level in the ESSF variants. Within the RSA it is likely that there are many other undocumented occurrences that would alter the context of the loss of ECAR in the ESSF variants. Past, present, and future projects are not expected to reduce the amount of ECAR in the ESSF further. ECAR in the ESSF are at low risk from future projects and are likely more abundant than current data suggests. ECAR in the IDF, which has higher risk regionally, had a minor impact from the Project. The impacts of past, present, and foreseeable-future projects in combination with the Project on ECAR in the ESSF or IDF variants is considered to be **not significant** (moderate).

15.6.5.3 Wetlands

The primary effect of the Project on wetlands identified in the LSA will be the direct loss of 70% of wetlands mainly at high elevations in the ESSF variants. Other wetlands in proximity to the mine have the potential to be affected by dust deposition. Most rare plants and both ECAR in the ESSF variants in the LSA are associated with wetlands. Mitigation for wetlands will reduce the effects for other VCs including rare plants and ECAR. Avoidance, protection, reclamation, and creation have all been proposed to reduce effects; however, the success of those programs is uncertain and requires monitoring with adaptive approaches.

Human settlement and development at lower elevations have had the greatest historic and ongoing effects on wetlands in the RSA. Forest practices generally maintain wetlands; however, livestock grazing can degrade wetland habitats and plant communities. Forestry and agriculture have likely damaged or reduced the function of wetlands within the RSA, but it is unlikely that the impacts to high-elevation wetlands would be substantial given limited access to high elevation wetlands in the RSA. During reclamation, 17.6 ha of wetland will be created, several pocket wetlands will be created (with the intention of providing western toad breeding habitat), and wetland areas within the LSA will be enhanced. This will partially mitigate the loss of 8% of high-elevation wetlands in the RSA. The cumulative effects of the Project effects and other projects and activities on wetlands in the RSA are considered **not significant** (moderate).

15.6.5.4 Old-growth Forests

Project Construction and Operations will remove 610 ha of old-growth forests, the majority of which is high-elevation ESSF old-growth. There remain about 40,000 ha of older forest within the RSA. OGMA were established by government to maintain representative areas (just under 17,000 ha) of old forest across the RSA. About 213 ha of recently designated OGMA will be completely removed by the Project.

The contributions of the Project in combination with other projects and activities in the RSA to have cumulative effects on old-growth forests are **not significant** (minor).

15.6.6 Confidence and Uncertainty in Determination of Significance

Confidence, which can also be understood as the level of uncertainty associated with the assessment, is a measure of how well residual effects and cumulative effects are understood and the confidence associated with the baseline data, modelling techniques used, assumptions made, effectiveness of mitigation, resulting predictions and knowledge of past projects, present projects, foreseeable-future projects, and activities.

Although general predictions of adverse rare plant effects are sound, the specific disturbance responses for the rare plants in the LSA are unknown. Furthermore, disturbance effects within BC are incomplete for many of the affected rare plant taxa. Knowledge of rare plant distribution within the RSA is limited. Therefore, the level of confidence for CEA of rare plants is low (Table 15.6-9).

The spatial accuracy of TEM used to identify locations and abundance of ECAR in the LSA is moderate, though it is expected that the current amount of ECAR predicted in the LSA is an underestimate of its occurrence within the RSA. There is uncertainty in the ability to predict locations of ECAR on the regional landscape without additional mapping. Consequently, the level of confidence for ECAR is considered moderate.

Vegetation Resource Inventory accuracy for delineating wetland is low due to the complexing of wetlands with meadow habitat and given the scale of the mapping. Therefore the quantitative estimation of wetlands lost in the RSA is likely underestimated. The success of wetland reclamation at high elevations is also unknown. Because of this uncertainty the level of confidence for the CEA of wetlands is low.

Vegetation Resource Inventory accuracy for delineating old-growth forests in the RSA is high. Because of this certainty the level of confidence for the CEA of old-growth forests is high.

15.6.7 Follow-up Programs

The Operational Policy Statement for Follow-up Programs provides the following definition for follow-up programs from the *Canadian Environmental Assessment Act, 2012* (2012):

- to verify the accuracy of the conclusions of the EA process for a designated Project; and
- to determine the effectiveness of any measures taken to mitigate the adverse effects of the Project.

Table 15.6-9. Summary of Key Cumulative Effects, Mitigation, Cumulative Residual Effects Characterization Criteria, Likelihood, Significance, and Confidence

Key Cumulative Effect	Mitigation Measures	Summary of Cumulative Residual Effects Characterization Criteria *(Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Resiliency)*	Likelihood *(High, Moderate, Low)*	Significance of Adverse Cumulative Residual Effects		Confidence *(High, Moderate, Low)*
				Scale (*Minor, Moderate, Major*)	Rating *(Not Significant; Significant)*	
Rare Plants Loss / Alteration	Avoid, protect (dust control), regional surveys in the ESSFwc2 for Howell's quillwort	A high-magnitude and regional effect is expected for rare plants. Loss of rare plants will occur only once, but the duration is permanent, and not reversible. The area has been moderately disturbed by previous human development. Several rare plant occurrences have persisted on the landscape despite proximity to past and present projects.	High	Major	Unknown	Low
ECAR Loss / Alteration	Avoid, protect (dust control), regional surveys	A high-magnitude but local effect on ECAR is expected. Loss of ECARs will only occur once within any given Project footprint. The duration is permanent, and not reversible. The area has been moderately disturbed by previous human development. ESSF ECAR are at low risk from future projects and are likely more abundant than current data suggests. IDF ECAR, which has higher risk regionally, had a minor impact from the Project.	Moderate	Moderate	Not significant	Moderate
Wetlands Loss / Alteration	Reclamation, wetland enhancement	A moderate-magnitude regionally and major local effect of Project Construction on wetlands is expected. Loss of wetlands will only occur once, and reclamation activities are expected in some of this wetland area during Closure. The RSA and associated wetlands have been disturbed and fragmented by previous human development (forestry, cattle grazing, recreation). Past, present, and foreseeable-future project and activities have likely impacted lower elevation wetlands.	High	Minor	Not Significant	Low

(continued)

Table 15.6-9. Summary of Key Cumulative Effects, Mitigation, Cumulative Residual Effects Characterization Criteria, Likelihood, Significance, and Confidence (completed)

Key Cumulative Effect	Mitigation Measures	Summary of Cumulative Residual Effects Characterization Criteria *(Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Resiliency)*	Likelihood *(High, Moderate, Low)*	Significance of Adverse Cumulative Residual Effects		Confidence *(High, Moderate, Low)*
				Scale (*Minor, Moderate, Major*)	Rating *(Not Significant; Significant)*	
Old-Growth Forests Loss / Alteration	Reclamation, ID replacement OGMA	A moderate-magnitude and local effect of Project Construction on old-growth forests is expected. Loss of old-growth has occurred sporadically in the RSA, and although the duration of impacts is long-term, given time younger forests will regenerate if left undisturbed. Approved OGMAs are distributed throughout the RSA.	Low	Moderate	Not Significant	High

15.6.7.1 Rare Plants and Ecosystems at Risk

The confidence in the characterization of the residual Project effects to rare plants was considered to be low. Based on the current information rare plants will experience significant adverse cumulative effects. However, this is the artifact of a lack of regional knowledge. Although general predictions of adverse rare plant effects are sound, the distribution of rare plants outside of the survey areas is unknown. As such, it is difficult to determine the scale of the effect of the Project on rare plant abundance and distribution. Establishing the distribution and extent of additional rare plant occurrences within the ESSFwc2 could help better characterise the regional impacts of the project.

Similarly, knowledge of the presence and distribution of ECAR in the RSA is limited. Establishing the distribution and extent of additional ECAR occurrences within the ESSFwc2 would help better characterize the effects of the Project and enable a determination of significance.

Additional field surveys in the ESSFwc2 within the RSA for rare plants specifically for Howell's quillwort should be conducted as part of a Follow-up Program, the details of which are discussed in the Vegetation Management Plan (Section 24.17).

15.6.7.2 Wetlands

Due to the complex mosaic of wetlands and upland terrestrial ecosystems located in the proposed TMF area, accurate mapping of these areas on hardcopy photos is challenging and potential overestimates of wetland extent can occur. Use of new technologies such as new high resolution imagery and light detection and ranging (LIDAR) provide much greater resolution and allow for more accurate delineation and interpretation of ecosystem boundaries and types. During final Project design, new imagery, LIDAR, or other high resolution remote sensing data may be required. A follow program to re-map the wetlands in and directly adjacent to the TMF should be conducted to more accurately characterize wetland extent and type. This information would refine the total loss of wetland extent caused by the project and inform reclamation.

15.7 CONCLUSIONS FOR VEGETATION

The scoping process identified four vegetation VCs: rare plants, ECAR, wetlands, and old-growth forests. Potential effects of the Project include habitat loss for all four VCs and alteration of only wetlands. Despite application of mitigation measures, residual effects are predicted for all four VCs. Significant residual effects are anticipated for the loss of rare plants, ECAR, and wetlands within the LSA. Loss of old-growth forests and alteration of wetlands is considered not significant at the Project level. A summary of the Project related and cumulative effects, mitigation and their significance are provided in Table 15.7-1.

An assessment of cumulative effects was conducted to evaluate evaluated the effects of the Project in addition to past, present and reasonably foreseeable future activities (i.e. forestry, agriculture and recreation) in the RSA. A scoping process identified which vegetation VCs, additional projects and potential effects were to be evaluated (Section 15.6). The four VCs with residual effects were evaluated (rare plants, ECAR, wetlands, and old-growth forests) and each was found to have potential cumulative effects. All of the VCs were found to interact with agriculture and forestry activities, and a minor cumulative interaction for rare plants and ECAR is possible based on sawmills in Vavenby and Barriere and the Trans Mountain Pipeline. The loss of wetlands in the RSA

as a result of all projects and activities is considered to be a not significant cumulative effect. The majority of ECAR locations within the LSA are in areas that have been previously harvested in the last century, but the cumulative effect is considered not-significant. Establishing the distribution and extent of additional rare plant occurrences within the ESSFwc2, as proposed in the Vegetation Management Plan (Section 24.17.3), would help better characterise the regional impacts of the project. Based on current information a determination on the cumulative effects on rare plants cannot be made.

Table 15.7-1. Summary of Key Project and Cumulative Residual Effects, Mitigation, and Significance for Vegetation

Key Residual Effects	Project Phase	Mitigation Measures	Significance of Residual Effects	
			Project	Cumulative
Rare Plants				
Loss	Construction	Avoidance where possible, protect (dust control), regional surveys in the ESSFwc2 for Howell's quillwort.	Significant (major)	Unknown
ECAR				
Loss	Construction	Avoidance where possible, protect (dust control), reclamation during closure.	Significant (major)	Not significant (moderate)
Wetlands				
Loss	Construction, Operations, Closure and Post-Closure	Avoidance where possible. Reclamation during Closure.	Significant (major)	Not Significant (moderate)
Alteration	Construction, Operations, Closure and Post-Closure	Avoidance, where possible.	Not significant (minor)	N/A
Old growth				
Loss	Construction	Reclamation, ID replacement OGMA	Not Significant (moderate)	Not significant (minor)

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