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5.4.6 Plant Species and Ecosystems at Risk

5.4.6.1 Introduction

Each indicator was selected for inclusion in the assessment taking into consideration the baseline study findings, the conservation status, and inputs from local stakeholders, government agencies, and regulators. Indicator selection was based on ecosystems that have intrinsic ecological or social value, are representative of overall ecosystem condition, and are sensitive to the Project activities. Three indicators were selected:

1. Whitebark pine.
2. Potential plant species-at-risk habitat.
3. Ecosystems at risk.

The interactions of the Project with the Ecosystem Composition Valued Component (VC) and the Plant Species and Ecosystems at Risk VC are closely linked. Vegetation and soil disturbance will result in ecosystem loss. Ecosystem loss will likely reduce habitat suitable for plant species and ecosystems at risk.

Key interactions that have greater potential to result in significant adverse residual effects on plant species and ecosystems at risk occur both within the mine site and within the linear components (e.g., transmission line). Where the alteration of baseline ecosystems are disturbed in such as way that baseline conditions cannot be reclaimed and will be permanently lost such is considered a key interaction. This is the case within the mine site where the loss of whitebark pine is a direct result of clearing for mine facilities during construction phase (e.g., open pit and tailings storage facilities). Furthermore, along the transmission line where habitat alteration and ecosystems at risk interact, the result is also a key interaction. The reason for this is because the ecological complexity of an ecosystem at risk cannot confidently be reclaimed; thus, a key interaction.

Where mitigation and reclamation have the ability to restore baseline conditions interactions are considered moderate. Such is the case where the project does not interact with plant species at risk or ecosystems at risk directly. At closure, these landforms will be reclaimed using native species mixes similar to baseline ecosystem species, and with mitigation measures implemented are expected to return to similar ecosystem types over time.

The indicators used to evaluate potential key effects on the Plant Species and Ecosystem at Risk VC include whitebark pine, potential plant species at risk habit, and ecosystems at risk.

5.4.6.1.1 Relevant Legislation and Legal Framework

The vegetation section is a requirement of the British Columbia *Environmental Assessment Act* (BC *EAA)* (Government of BC, 2002a) and the *Canadian Environmental Assessment Act, 2012* (*CEA Act 2012*) (Government of Canada, 2012). The BC *Mines Act* (Government of BC, 1996a) requires a vegetation assessment, along with development of an environmental management and reclamation plan to support the mitigation and decommissioning/closure of the Project.

The plant species at risk section is included under the requirements of the BC *EAA* (Assessment of Vegetation). The federal *Species at Risk Act* (*SARA*) (Government of Canada, 2002) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), together with the BC *Forest and Range Practices Act* (*FRPA*) (Government of BC, 2002b) lists plant species at risk. The BC FRPA lists endangered or threatened plants and plant communities. The British Columbia Conservation Data Centre (BC CDC) recognizes species and ecosystems at risk; however, no legislation supports their rankings.

Invasive plant designation and legislation are addressed by the BC Ministry of Agriculture *Weed Control Act* (Government of BC, 1996b), and the invasive plant regulation by a Provision of the *FRPA* (Government of BC, 2002b), c. 69, relevant to enactment of this regulation: sections 47 and 141.

5.4.6.2 Valued Component Baseline

5.4.6.2.1 Information Sources

The site-specific baseline report (Vegetation Baseline Report, **Appendix 5.1.3.3A**) for the Project enabled assessment of potential effects. Review of Provincial and regional information sources provided a background to identify potential plant species at risk in the Project area. The British Columbia Ministry of Environment's (BC MOE) Endangered Species and Ecosystems—Non Sensitive Occurrences and Endangered Species and Ecosystems—Masked Sensitive Occurrences (BC CDC, 2013) revealed any occurrences within 50 km of the Project area. The absence of recorded occurrences does not necessarily mean there are no species or ecosystems at risk in the Project area, only that there is no record of such species or ecosystems in the BC CDC database. Queries of the BC CDC database generated a list of plant species at risk that might occur in the Project area. The BC CDC (2013) defines an ecosystem at risk as a community that is extirpated, endangered, threatened, or of special concern—either Red-listed or Blue-listed.

5.4.6.2.2 Spatial Boundaries

The Project study area is the collective term for the local study areas (LSA) and regional study areas (RSA) of the proposed mine site and associated components: mine access road, Kluskus Forest Service Road (FSR), transmission line, freshwater supply system, and airstrip that is the same as used for the Ecosystem Composition VC (**Section 5.4.5**).

The AIR describes the LSA as follows (**Table 4.3-1** of **Section 4**):

- Mine Site: 500 m from the proposed Project mine site boundary; and
- Transmission line, mine access road, airstrip, freshwater supply pipeline, and Kluskus FSR: 100 m beyond the proposed linear component boundary.

The rationale in the AIR for the LSA is as follows (**Table 4.3-1** of **Section 4**):

- Includes the entire mine site where soil and vegetation will be removed and considers a buffer to take into account potential edge effects and particulate matter deposition; and
- Includes entire linear components and a buffer to take into account potential edge effects and particulate matter deposition. The buffer for the linear components is smaller given that vegetation or soil removal will be conducted in lower quantities.

The LSAs of the mine site access road, freshwater supply system, airstrip, transmission line, and Kluskus FSR extend 100 metres (m) beyond their corridors in either direction. The corridor is the area defined as the right-of-way (ROW) plus a 50 m buffer. The ROW for all linear features is 20 m with the exception of the transmission line, which is 40 m; the freshwater supply line and airstrip access is 10m; and the airstrip is 200 m wide corridor (100 m ROW with 50 m buffer each side) for the whole corridor with no ROW. The mine site LSA includes the proposed footprint and a buffer zone of 500 m around the proposed mine site. The combined total area of all LSAs is approximately 14,000 ha. The various LSAs are meant to circumscribe the boundaries of the effects of the Project components, including a buffer zone. The LSAs encapsulate any predicted contiguous effects from activities that may cause disturbance to the natural vegetation surrounding the proposed mine footprint and other Project components.

The AIR describes the RSA as follows (**Table 4.3-1** of **Section 4**):

- Mine Site: 3,000 m from the proposed Project mine site boundary; and
- Transmission line, mine access road, airstrip, freshwater supply pipeline and Kluskus FSR: 500 m beyond their proposed linear component boundary.

The rationale in the AIR for the RSA is as follows (**Table 4.3-1** of **Section 4**):

- Considers an additional buffer around the LSA to take into account potential interactions with other projects or activities.

The regional study area (RSA) is one continuous boundary surrounding all of the proposed features of the Project and totals approximately 31,000 ha exclusive of the LSA. **Figure 5.4.6-1** shows summaries and the Project LSAs and RSAs.

A Cumulative Effects Study Area (CESA) includes past, present, and reasonably foreseeable future human activities likely to result in residual effects or effects on each VC; only those human activities having residual effects, which have a temporal and spatial overlap with the Project's residual effects, are considered. The spatial limits of the CESA are consistent with the RSA.

5.4.6.2.3 Temporal Boundaries

The temporal boundary is a reasonable expectation of the time over which the Project could affect the selected VCs, and is the same as for the Ecosystem Composition VC (**Section 5.4.5**).

5.4.6.2.4 Administrative Boundaries

The project falls within three administrative regions: Region 5: Cariboo; Region 6: Skeena; and Region 7A: Omineca. It is also administrated by the Vanderhoof Land and Resource Management Plan (LRMP) (BC MFLNRO, 1997). Refer to **Section 7** for detailed land-use management and zoning.

5.4.6.2.5 Technical Boundaries

Knowledge of the ecosystems potentially affected by the Project is based on ecosystem maps prepared for the Project, field surveys, and professional judgement of the study team. Ecosystem maps prepared for the Project were designed to meet the specific standards with respect to mapping scale and survey intensity to support the planned uses. Field surveys were based on provincial standards and protocols. Information and spatial data sources used in the assessment included BC Vegetation Resource Inventory (VRI) Mapping, Predictive Ecosystem Mapping (PEM) of the Vanderhoof Forest District and the Land Management Handbook (LMH) (DeLong et al., 1993). Plant species and ecosystems at risk were identified using the BC Conservation Data Centre (BC CDC) database, both Element Occurrence Records and BC Species and Ecosystem Explorer.

5.4.6.2.6 Methods

Terrestrial ecosystem mapping (TEM) was completed to provincial standards (RIC, 1998), based on 3D aerial photograph interpretation and bioterrain for the following project components: mine site, mine site access road, freshwater supply system, and airstrip. A modified TEM was completed for the transmission line, based on 2D aerial photograph interpretation and bioterrain. The existing Kluskus FSR was mapped using existing PEM data, and cross-referenced with available 2D imagery and VRI where available. Further details can be found in the Vegetation Baseline Report (**Appendix 5.1.3.3A**); however, for convenience some are included below.

Based on the Standards for Terrestrial Ecosystem Mapping in British Columbia (RIC, 1998), three different survey intensity levels (SIL) were used to assist the ecosystem mapping process (**Table 5.4.6-1**). The mine site was given the highest SIL due to the degree of disturbance anticipated in the area; SIL-3 or 26% to 50% of polygon inspection. Whereas for linear components, such as the water pipeline and transmission line, where less disturbance was anticipated, SIL-5 or 5% to 14% polygon inspection. For existing linear components such as the Kluskus Forest Service Road (FSR) where very limited disturbance was anticipated due to a possible re-alignment upgrade, reconnaissance level survey or 0% to 4% of polygon inspection. Ecosystem mapping was completed at a scale of 1:5,000 for all project components with the exception of the existing Kluskus FSR, which used 1:20,000 scale Predictive Ecosystem Mapping (PEM).

Field data was collected over a three year period during July and / or August of 2011, 2012 and 2013. Three types of survey data were included: TEM, plant species at risk and select wetland plots. During the first two years (2011 and 2012) separate TEM and plant species at risk surveys were conducted which targeted the proposed mine site. The third year (2013) the TEM survey crew was accompanied by a plant species at risk specialist that searched for plant species at risk while the TEM crew completed their survey. In 2013, 148 plots were completed which focussed along the Transmission Line, the updated mine footprint and new project components.

5.4.6.2.6.1 Plant Species At-Risk

A plant species at risk field program was conducted over a period of three years: targeted species-at-risk surveys in 2011 (July and August) and 2012 (July), and an integrated species-at-risk survey in 2013 (July). The latter was a combination TEM and plant species-at-risk survey. One terrestrial plant species at risk was documented within the Project LSA—whitebark pine (*Pinus albicaulis*); a SARA-listed and provincially Blue-listed species. Whitebark pine occurs at higher elevations along the southern end of the Project area. The whitebark pine population extends from the open high-elevation forest of the Nechako Moist Very Cold Engelmann Spruce-Subalpine Fir Parkland variant (ESSFmv1p) down into the continuous forested area of the Nechako Moist Very Cold Engelmann Spruce-Subalpine Fir variant (ESSFmv1). The ESSFmv1p is transitional to the Engelmann Spruce-Subalpine Fir Very Dry Very Cold Chilcotin Parkland variant (ESSFxvp1). Based on fieldwork the whitebark pine population extends into the mine footprint and overlaps with the proposed open pit.

Subsequent to the 2011 plant species-at-risk survey, the Proponent initiated a targeted whitebark pine program. Four field surveys took place in 2012 and 2013. The objectives of the field surveys were four-fold: 1) collect cones from phenotypically rust-resistant trees that would be used to initiate production of potentially rust-resistant seedlings, 2) identify potential mitigation areas adjacent to the proposed mine footprint, 3) document the local extent of whitebark pine, and 4) conduct seedling/sapling transplant trials. This program is a multi-year initiative culminating in a five-year whitebark pine management plan.

Four other Blue-listed plant species were confirmed but occur exclusively in wetlands and are therefore addressed in the Wetland VC section (**Section 5.3.7**).

5.4.6.2.6.2 Potential Plant Species At-Risk Habitat

A desktop survey provided a list of potentially occurring plant species at risk. This involved reviewing element occurrence records from the BC CDC and ecosystem data from the BC Species and Ecosystem Explorer (BC CDC, 2013). This list included all plants from the following Biogeoclimatic (BGC) units:

- SBSdk (Dry Cool Sub-Boreal Spruce subzone);
- SBSdw3 (Stuart Dry Warm Sub-Boreal Spruce variant);
- SBSmc2 (Babine Moist Cold Sub-Boreal Spruce variant);
- SBSmc3 (Kluskus Moist Cold Sub-Boreal Spruce variant);
- ESSFmv1 (Nechako Moist Very Cold Engelmann Spruce-Subalpine Fir variant);

- ESSFmv1p (Nechako Moist Very Cold Engelmann Spruce-Subalpine Fir Parkland variant); and
- BAFAun (Undifferentiated Boreal Altai Fescue Alpine subzone).

The BC CDC database (Vegetation Baseline Report **Appendix 5.1.3.3A**) listed 159 plant species at risk that could occur in the Project area. A comprehensive review of additional existing North American databases reduced this number to 10 vascular plants. A list of habitat preferences was compiled for each potential plant species at risk using literature sources (Douglas et al., 1998–2002; Klinkenberg, 2013; Ball and Reznicek, 2002). Most of the potentially occurring plant species at risk could be eliminated because their range was far outside of the Project area. Wetland and aquatic plants could be removed from the provisional list because they are addressed in the Wetland EA report (**Section 5.3.7**). Insufficient habitat data meant that bryophytes could be removed. As a result, two Red-listed and eight Blue-listed plant species at risk, none of which are SARA-listed, were identified (**Table 5.4.6-1**).

Table 5.4.6-1: List of Potentially Occurring Plant Species-At-Risk in the Project Area and their Habitat Requirements

Scientific Name	Common Name	BC List	Provincial Rank	Global Rank	Habitat
Botrychium crenulatum	dainty moonwort	Blue	S2S3 (2013)	G3 (2011)	Grows in saturated soils of seeps and along the stabilized margins of small streams, often among dense herbaceous vegetation. It also occurs occasionally in seasonally wet roadside ditches and drainage ways. It is usually found in partly to heavily shaded sites at mid to high elevations
Carex backii	Back's sedge	Blue	S2S3 (2003)	G5 (2012)	Dry, rocky, open, or shaded slopes, ridges, and barrens, in hardwood, mixed, or coniferous forests, including pine plantations, on acidic and calcareous substrates
Carex lenticularis var. *dolia*	Enander's sedge	Blue	S2S3 (2001)	GNR	An infrequent taxon of high elevations in the northern Rocky Mountains found on gravelly soils on seasonally flooded stream and lakeshores or seeps
Carex tenera	tender sedge	Blue	S2S3 (2000)	G5 (1996)	Dry to moist, open forests and meadows
Chenopodium atrovirens	dark lamb's-quarters	Red	S1 (2011)	G5 (1998)	In BC known from Osoyoos area, but one Eastham collection from Fort St. James (1944). Open dry sandy areas and other disturbed sites
Draba densifolia	Nuttall's draba	Blue	S2S3 (2001)	G5 (1990)	Rock outcrops and talus, rocky knolls, alpine ridges
Draba ruaxes	coast mountain draba	Blue	S2S3 (2000)	G4 (2006)	Rock outcrops, talus slopes, ridges, alpine summits
Salix boothii	Booth's willow	Blue	S2S3 (2000)	G5 (1993)	Meadows, seepages, streams, & lakeshores
Silene drummondii var. *drummondii*	Drummond's campion	Blue	S3 (2001)	G5T5 (1997)	Dry, often sandy or gravelly places, prairies, dunes, bluffs, hillsides, sagebrush, open montane woodlands and forests
Symphyotrichum ascendens	long-leaved aster	Red	S1S3 (2005)	G5 (1988)	Meadows, grasslands, damp areas in sagebrush steppe and ponderosa pine woodlands

Note: Red-listed = species and subspecies that are extirpated, endangered, or threatened in BC
Blue-listed = species and subspecies of special concern in BC
Provincial Rank = conservation status rank for an element occurring or formerly occurring in BC
S1 = critically imperiled in the nation or province because of extreme rarity (often five or fewer occurrences), or because of some factor(s) such as very steep declines, making it especially vulnerable to extirpation from the nation/province
S2 = imperiled in the nation or province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation/province
S3 = vulnerable in the nation/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation
Global Rank = conservation status for an element, as determined by NatureServe, based on information provided by Natural Heritage Programs and Conservation Data Centers
G3 = vulnerable, at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors
G5 = secure, common; widespread and abundant; GNR = unranked, global rank not yet assessed
T = subspecies ranking

5.4.6.2.6.3 Ecosystems at Risk

The BC CDC (2013) defines an ecosystem at-risk as a community that is extirpated, endangered, threatened, or of special concern, Red- or Blue-listed (BC CDC, 2013); but unlike some plant species at risk, ecosystems have no legislated status. The BC CDC maps known locations of Red- and Blue-listed ecosystems. There were no BC CDC element-occurrence records for ecosystems at risk in the Project LSA.

Thirteen upland ecosystems at risk potentially occur in the Project area. Two are the same ecosystem, but occur in different BGC variants; these are the grassland communities (**Table 5.4.6-2**). Four ecosystems were confirmed by plot data: three plots in the Lodgepole pine–Common juniper–Rough-leaved ricegrass (SBSdk 02/LJ), one plot in the Drummond's willow–Bluejoint reedgrass (SBSdw3 Fl05), one plot in the Black cottonwood–Spruce–Red-osier dogwood (SBSdk 08/CD), and one plot in the Saskatoon–Slender wheatgrass (SBSdw3 81/SW).

In total, 10 ecosystems at risk were mapped in the LSA (**Table 5.4.6-2**). All upland ecosystems at risk occur along the proposed transmission line and existing Kluskus FSR. No ecosystems at risk occur in the mine site LSA. For more details and maps showing their distribution, refer to the Vegetation Baseline Report (**Appendix 5.1.3.3A**).

Table 5.4.6-2: Baseline Ecosystems-at-Risk in the LSA

BGC	Ecosystem Group	Site Series	Map Code	Ecosystem	BC List	Plot Number	Mapped in LSA
SBSdk	Grassland	82	BW	Sandberg's bluegrass–Slender wheatgrass	Red		×
	Grassland	81	SW	Saskatoon– Slender wheatgrass	Red		✓
	Forest	02	LJ	Lodgepole pine–Common juniper–Ricegrass	Blue	T-12-G226; T-12-G212; T-12-G026	✓
	Forest	04	DS	Douglas-fir–Soopolallie–Feather moss	Blue		✓
	Riparian	08	CD	Black cottonwood–Dogwood–Prickly rose	Red	T-12-G208	✓
	Flood	00	Fl02	Mountain alder–Red-osier dogwood–Lady fern	Blue		×
	Flood	00	Fl05	Drummond's willow–Bluejoint	Blue		✓
SBSdw3	Grassland	82	BW	Sandberg's bluegrass–Slender wheatgrass	Red		×
	Grassland	81	SW	Saskatoon–Slender wheatgrass	Red	T-12-G214	✓
	Forest	02	DC	Douglas-fir–Lodgepole pine–Cladonia	Blue		✓
	Forest	05	BF	Lodgepole pine–Black spruce–Feathermoss	Blue		✓
	Forest	06	SS	Hybrid white spruce–Pink spirea–Prickly rose	Blue		✓
	Flood	00	Fl05	Drummond's willow–Bluejoint	Blue	T13-020G	✓

Note: BGC = Biogeoclimatic; SBSdk = Dry Cool Sub-Boreal Spruce; SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant

5.4.6.2.7 Past, Present and Future Projects and Activities

Past, present or future projects and activities associated with development of the Project have the potential to affect plant species and ecosystems at risk. A comprehensive list of past, present and future project and activities located within the RSA for all selected VCs is presented in **Appendix 4C** and is summarized in **Table 4.3-11**. The project and activities with the potential to affect the VC include recreational activities, forestry activities, transportation and access, mining activity, trapping and guide outfitting, traditional land use, and other projects such as the Nulki Hills Wind Project.

5.4.6.2.8 Traditional Knowledge

Plant species and ecosystems at risk are important objectives for local residents and Aboriginal groups. These groups' comments during the engagement and consultation process have provided insights into traditional, ecological, or community knowledge, which is defined as a body of knowledge built up by a group of people through generations of living in close contact with nature.

Berry picking and plant gathering still occurs today. Interviews conducted with members from Saik'uz First Nation, Stellat'en First Nation, Ulkatcho First Nation and Lhoosk'uz Dene Nation demonstrate reliance on plants for food. Summer season is when berries are picked. Representatives from the First Nation groups noted they consume soapberries, huckleberries, raspberries, strawberries, and blueberries. Areas where berry picking occur include the east side of Tatelkuz and some areas near the Stellaquo River.

Consultation with the public did not uncover any sensitive plant species although concern over the spread of invasive plant species was noted. Whitebark pine is a species at risk and is considered endangered. Public consultation noted the presence of Clark's nutcracker in the project area is an indication of the presence of whitebark pine.

5.4.6.3 Potential Effects of the Proposed Project, and Proposed Mitigation

This subsection will identify and analyze potential adverse effects resulting from the proposed Project's construction, operations, closure and post-closure phases; identify and describe any potential adverse effects from other known past, present, certain and reasonably foreseeable future project or activities in the proposed Project area; and describe measures to mitigate the potential adverse effects (**Section 5.4.6.3.6.5**; **Section 5.4.6.3.7.5**) .

5.4.6.3.1 Identification and Description of Potential Adverse Effects from Other Past, Present, and Certain or Reasonably Foreseeable Future Project or Activities

Table 4.3-11 shows the Summary Project Inclusion List developed for cumulative effects assessment. A number of projects and human activities contain spatial overlap with the proposed features of the Project. These include recreational activities, forestry activities, transportation and access, mining activity, trapping and guide outfitting, traditional land use, and other projects. Some of these can be quantified, including the Nulki Hills Wind Project, mining activity (quarries and prospecting), forestry cutblocks and woodlots, and forestry-related roads. The RSA is a total of 45,000 ha (including the LSA), of which 14,689 ha interacts with these other projects or activities. **Section 5.4.6.5** describes in detail the cumulative effects on the Ecosystem Composition VC.

The MPB infestation has affected large areas of mature pine forest in the region, some of which were harvested. Stands with a low proportion of pine affected by MPB and not harvested remain as altered but functioning ecosystems on the landscape.

5.4.6.3.2 Assessment Cases

The LSA boundaries are used to assess plant species and ecosystems at risk. Assessment included potential cumulative effects of the Project, along with other past, present, or reasonably foreseeable projects in the Cumulative Effects Study Area (CESA).

The following sections present the assessment of how each component of the Project—construction, operation, closure, and post-closure—may affect the three indicators: whitebark pine habitat, potential plant species-at-risk habitat, and ecosystems at risk. Mitigation measures to reduce or eliminate potential effects of the Project on plant species and ecosystems at risk were identified during each Project Case.

Because environmental effects to vegetation resources are primarily concentrated in the construction phase, with little change in conditions anticipated during the operations and closure phases, these three phases will be treated as a single scenario, defined as the Project Case. Assessment Cases will include the Baseline, Project, and Post-closure, and are described in more detail below.

- The ‘Baseline Case’ represents vegetation conditions prior to Project specific developments. The baseline for vegetation incorporates the environmental effects of existing human-caused disturbances (e.g., forest harvesting, roads, other mine footprints, etc.);
- The ‘Project Case’ represents the Baseline Case with the addition of the Project footprint for the construction, operations, and closure phases. While recognizing that development, decommissioning, and reclamation will be progressive throughout the Project, the Project Case represents the maximum disturbance scenario; and
- The ‘Post-Closure Case’ represents conditions forecast into the future at the start of the Post-Closure phase (i.e., following decommissioning and closure of the mine). This scenario assumes implementation of all mitigation recommendations and components of the Conservation and Reclamation Plan, and that measures of success have been met.

5.4.6.3.3 Key Effects

The evaluation of potential Project effects on whitebark pine, potential plant species-at-risk habitat and ecosystems at risk on all project components is based on five key effects:

1) Ecosystem loss.
2) Dust deposition.
3) Nitrogen (N) deposition.

4) Spread of invasive species.
5) Whitebark pine regeneration.

5.4.6.3.3.1 Ecosystem Loss

The largest effect on the Plant and Ecosystems at Risk VC will be the loss of baseline ecosystems, referred to as *ecosystem loss*. The removal of vegetation during the construction phase—which includes site clearing, salvage/stripping of surface soil, site grading and stockpiling of salvaged materials, as well as removal and alteration of overburden—will result in ecosystems loss. During construction, vegetation will be removed, including roots and propagules. The environmental effects of ground disturbance can lead to changes in soil moisture and soil nutrient regimes, resulting in changes to conditions necessary for ecosystem development. During operations, further vegetation disturbance is expected to be limited.

The reclamation approach for the Project includes the incorporation of mine-related landforms into the landscape and re-establishment of natural landforms in the remaining sites.

- Mine-related Landforms—Derived from mining activities (i.e., open pit, tailing storage facilities, waste rock dumps) and will be reclaimed into rocky slopes, slopes with upland beach, wetlands, permanent ponds and a pit lake; and
- Natural Landforms—The natural landforms will have characteristics and relief similar to the pre-mining conditions. These include the areas of decommissioned mine buildings and infrastructure, the transmission line, and the freshwater system, including the water pipeline.

The reclamation design of mine-related and natural landforms will target the reclamation of pre-disturbance ecosystems on natural landforms, and establishing whitebark pine forest on the waste rock piles where possible.

5.4.6.3.3.2 Dust Deposition

Dust generated by the project could affect plant photosynthesis, respiration, and transpiration, and allow the penetration of phytotoxic gaseous pollutants, eventually reducing plant growth and density. The main Project activities producing dust (particulate matter or ‘PM’) will be land clearing, excavating and grading during construction, and mine fleet operations, material handling, ore processing, and vehicular traffic during operations (**Section 5.2.4**). This includes fixed (internal combustion engines) and mobile (vehicles) sources of dust.

Fugitive dust emissions may be elevated during times of high winds and dry weather (EPA, 1995). A number of variables influence the effect of dust on vegetation:

- The concentration of dust particles in the ambient air;
- Deposition rates;
- Size distribution of dust particles;

- Dust chemistry;
- Meteorological and local microclimate conditions;
- The degree of penetration of dust into vegetation; and
- Plant morphology, such as leaf surface roughness and wetness.

Plant species vary in their susceptibility to dust. Low-growing species such as bryophytes and lichens have been found to be particularly sensitive to dust deposition (Walker and Everett, 1987; Farmer, 1993).

5.4.6.3.3.3 Spread of Invasive Plants

BC's Ministry of Forest and Range (BC MOFR) (2010) defines invasive plants as those that are not native to BC, and that have the potential to pose a threat to the natural environment. Invasive plants are extremely aggressive, and can out-compete native vegetation, leading to dense, widespread infestations of invasive plants. Through competition for water, nutrients, and space, invasive plants displace native species and can disrupt natural ecosystem function. Lacking natural pathogens or predators, invasive plants can quickly spread, and potentially negatively affect species and ecosystems at risk. As a result, the diversity of native plant communities is reduced, and ecosystem composition changes.

Disturbance of soil and movement of machinery and equipment in such areas as the mine site, mine site access road, airstrip, freshwater supply system, and transmission line can introduce invasive plants into the ecosystems of the Project area. Once invasive plants are introduced, further disturbance can facilitate the spread from one area to another. Within the proposed mine site, transmission line, and Kluskus FSR baseline surveys confirmed the presence of two invasive plants and 232 records of 24 invasive plant species identified by the Invasive Alien Plant Program (IAPP) (BC MFLNRO, 2013). Invasive plants are a potential effect, and a management concern.

5.4.6.3.3.4 Nitrogen Deposition

Mining construction and operations will produce air emissions from a number of sources, with internal combustion engines as the primary output—from vehicles and equipment—as well as incinerator emissions (**Section 5.2.4**).

Nitrogen (N) deposition represents the sum of N species (e.g., NO, NO_2, HNO_3, and NO_3^-). As N is a nutrient, deposition of N substances can influence aquatic and terrestrial ecosystems. As different plant species in these ecosystems respond to N loading differently, N deposition can potentially change ecosystem composition.

Nitrogen is one of the most important limiting elements for plant growth, particularly in nutrient-poor habitats. Plants growing in these ecosystems are adapted to low nutrient conditions and are typically not able to compete with other plants when nutrient levels increase, and can result in changes to species composition (Bobbink et al., 1998; Bobbink et al., 2002). Nitrogen deposition can increase growth of plants (Innes, 1991), but it may be the faster growing tree species (lodgepole pine and subalpine fir) that may benefit and grow faster, as a result of fertilization, compared to whitebark pine.

Increased soil N can also lead to a change in allocation of carbohydrates from roots to shoots (i.e., smaller root systems)—making trees in the affected area, including the SARA-listed whitebark pine, potentially more susceptible to blowdown or drought stress (Grulke et al., 1998; Margolis and Waring, 1986). In addition, susceptibility to insect attack and/or white pine blister rust infection may be heightened if trees produce more needles, or needles with different properties, as a result of exposure to increased N levels (Throop and Lerdau, 2004). Long-term potential changes to ectomychorrhizal community assemblages may result with N increase (Keane et al., 2011, Lilleskov et al., 2002). Mycorrhizal networks are important to whitebark pine, so changes in community composition may impact long-term health of affected trees. Increased N may increase competitive stress.

Ecosystems and plant species vary in their sensitivity to N deposition. In general, sensitive ecosystems are those that occur in cold climates with long frost periods, and on dry soils with low base-cation activity (Bobbink et al., 1998). Wetlands, alpine, and bog communities, and lichens and bryophyte species have been shown to be especially sensitive to air emissions (Bobbink et al., 2002).

Sulphur dioxide (SO_2) and N dioxide (NO_2) emissions have been shown to impact vigour and ecosystem composition by tissue absorption and by soil acidification (Bobbink et al., 1998; Richardson and Cameron, 2004). Air emissions modelling for the Project predicted that levels for SO_2 will be below BC Ambient Air Quality Guidelines (Air Emissions, **Section 5.2.4**), and therefore are not carried forward into the assessment.

5.4.6.3.3.5 Whitebark Pine Regeneration

Whitebark pine regeneration is closely linked to the Clark's nutcracker (*Nucifraga columbiana)* population. The pine is an obligate mutualist and primarily depends upon the nutcracker for dispersal of its seeds (Barringer et al., 2012). The seeds of whitebark pine are the preferred food source for the Clark's nutcracker. Their habit of caching seed in the ground is the primary means by which whitebark pine regenerates (Keane et al., 2011). As the population of whitebark pine decreases because of disease, mountain pine beetle (MPB), fire exclusion, and climate change (COSEWIC, 2010), cone (seed) production declines. Consequently, the number of Clark's nutcracker available to disperse their seeds may be reduced (Barringer et al., 2012). Reduced seed dispersal in turn may result in a reduced ability of whitebark pine to regenerate. McKinney et al. (2009) report that nutcrackers do not occupy an area when the cone production drops below 130 cones/ha.

5.4.6.3.4 Effects Assessment

Effects were analyzed in terms of the likelihood of occurrence in relation to Project activities during the Project and Post-closure Cases. Project components are: mine site, mine site access road, fresh water supply system, airstrip, transmission line, and Kluskus FSR (**Table 5.4.6-3**). For each of the six components, only those Project activities that were deemed likely to affect the indicators are shown.

Table 5.4.6-3: Potential Environmental Effects from the Project on Plant Species and Ecosystems at Risk by Project Phase and Component

Project Component	Potential Environmental Effect/Issue	Pathways for Effects	Project Phase: Construction	Operations	Closure	Post-closure
Mine Site	Ecosystem loss	• Land clearing, excavating, and grading • Surface water diversion, ditching, and sediment pond development • Mining operations and removal of soils/ore	√	√		
	Dust deposition	• Land clearing, excavating, and grading • Vehicular traffic—fixed and moving sources	√	√	√	√
	Spread of invasive species	• Land clearing, excavating, and grading • Stabilization, re-contouring, and/or cover placement and revegetation • Monitoring and maintenance of soil stability and vegetation	√	√	√	√
	Nitrogen deposition	• Land clearing, excavating, and grading • Mining operations and removal of soils/ore • Mine site vehicular traffic • Other combustion engine emissions—fixed point source	√	√		
	Whitebark Pine Regeneration	• Removal of whitebark pine and its habitat, and/or impacts to reproduction may reduce local Clark's nutcracker populations, and in turn negatively affect whitebark pine regeneration	√	√	√	
Linear	Ecosystem loss	• Land clearing, excavating, and grading • Surface water diversion, ditching, and sediment pond development • Mining operations and removal of soils/ore	√	√		
	Dust deposition	• Land clearing, excavating and grading • Vehicular traffic- fixed and moving sources	√	√	√	√
	Spread of invasive species	• Land clearing, excavating, and grading • Stabilization, re-contouring, and/or cover placement and revegetation • Monitoring and maintenance of soil stability and vegetation	√	√	√	√

5.4.6.3.5 Potential Adverse Effects from Other Known Past, Present, Certain and Reasonably Future Project or Activities

The effects of past and present projects and activities that are present in the RSA, when measurable, are described in **Section 5.1.3.3** Vegetation Baseline Summary. If the residual effect of the proposed Project on the VC is determined to be other than negligible and a potential temporal or spatial interaction with a project or activity is identified, then a cumulative effects assessment will be conducted taking into account past, present, certain and reasonably foreseeable future project or activities. The Cumulative Effects Assessment is discussed in **Section 5.4.6.4**.

5.4.6.3.6 Methods for Quantifying Effects

5.4.6.3.6.1 Ecosystem Loss

To assess effects to plant species and ecosystems at risk for each Project component, the Project footprint was superimposed on the existing baseline ecosystem map, or, in the case of whitebark pine, over the mapped distribution of whitebark pine. Then the area of overlap or interaction was quantified using spatial overlay analysis. Next, assuming successful reclamation the Baseline Case was compared to the Post-closure Case (at Year 35) to determine the extent of any residual Project effects. The assessment of project effects is based upon this residual affected area.

5.4.6.3.6.2 Dust Deposition

Air emissions results show that the highest level of dust generation and subsequent deposition in the LSA is expected to occur during the construction and operations phases; with the majority of the total dust generated per day limited to the mine site area (Air Quality, **Section 5.2.4**). A smaller percent of the total dust emissions per day is predicted to occur on the Kluskus FSR, and mine site and airstrip access roads.

The amount of dust deposited on a particular area depends on a number of variables, including composition and moisture condition of the road surface, number and type of vehicles, topographic setting, wind characteristics, and vegetation structure (Walker and Everett, 1987; Meininger and Spatt, 1988; Farmer, 1993; Edvardsson and Magnusson, 2009). Information on how the total amount of dust per area per temporal scenario might affect the specific ecosystems in the Project area is unknown. However, dust deposition studies suggest that 70% to 75% of the dust is deposited within 10 m of the road, 93% by 30 m, and 97% by 125 m (Walker and Everett, 1987).

For the Project, several mitigation actions to reduce fugitive dust are planned, including wetting soil surfaces and using coarse aggregate materials for road surfacing. Based on these factors, a 50 m buffer distance from roads was selected to assess the effects of dust on vegetation. Given that the highest volume of fugitive dust (tonnes/day) is predicted for the mine site, and that particle size is more likely to include fine materials (Air Quality, **Section 5.2.4**), a 125 m buffer was used to assess dust effects in the mine area. Existing roads and other anthropogenic features (e.g., cultivated field, gravel pit, exposed soil, etc.) were not included in the dust assessment.

5.4.6.3.6.3 Spread of Invasive Plants

Vegetation removal and/or soil disturbance associated with various Project activities are expected to create conditions conducive to the colonization and proliferation of invasive plant species. These disturbance conditions will likely occur for all Project phases and components.

The potential for invasive plant species colonization and subsequent effects on VCs is based on the interaction of many variables and cannot be predicted based on current scientific knowledge or methods. Therefore, to mitigate potential effects due to the introduction of invasive plant species, best practices for managing invasive species outlined in the Invasive Species Management Plan (ISMP) (**Section 12.2.1.18.4.5**) will be implemented.

Practices provided in the Landscape, Soils and Vegetation Management and Restoration Plan (LSVMRP) (**Section 12.2.1.18.4.4**) and Reclamation and Closure Plan (RCP) (**Section 2.6**) also describe measures to manage invasive plant species for relevant Project phases or activities, and these practices will be implemented.

5.4.6.3.6.4 Nitrogen Deposition

Nitrogen deposition was calculated using the CALPUFF model (**Section 5.2.4**). The assumptions for the CALPUFF model are in **Section 5.2.4**. The chemistry module, together with the wet and dry deposition scheme in the model, predicts the rate of generation and deposition of sulfates and nitrates from precursor pollutants. All sources from the mine site facility emitting nitrogen oxides (NO_x) were modelled to calculate hourly deposition rates of HNO_3 and other N species. Results were then converted into annual average N deposition in kg/ha/yr at each receptor.

Critical N deposition load levels were based on recommendations in Bobbink et al. (2002) for arctic, alpine, scrub (5 $kg/ha^{-1}/yr^{-1}$to 10 $kg/ha^{-1}/yr^{-1}$), and boreal forest (10 $kg/ha^{-1}/yr^{-1}$ to 20 $kg/ha^{-1}/yr^{-1}$). Also taken into consideration for establishing a critical load level for the assessment was the recommendation of a critical threshold of 6 $kg/ha^{-1}/yr^{-1}$ for boreal forests (Nordin et al., 2005). Given that the ecosystems and species in the Project area are adapted to cool, low-fertility conditions, and therefore more sensitive to N deposition, a value of 5 $kg/ha^{-1}/yr^{-1}$ representing the most conservative critical load from alpine and scrub was chosen for determining exceedances. Based on data from air emissions modelling (**Section 5.2.4**, **Appendix 5.2.4A**), areas where N deposition exceedances were predicted to occur were overlain on baseline ecosystems and species at risk. A qualitative assessment of effects was based on a literature review of published impacts of N deposition on indicators occurring in the Project area.

The predicted level of N deposition for a portion of the Project at the southern edge of the mine site is expected to exceed critical load levels for boreal forests and arctic, alpine, and scrub habitats (Bobbink et al., 2002; CEMA, 2008).

5.4.6.3.6.5 Whitebark Pine Regeneration

To assess the effects of whitebark pine regeneration the result of the environmental assessment on Clark's nutcracker population was reviewed in **Section 5.4.9**. Clark's nutcracker, is ranked as a nonsignificant effect with a moderate rating based on the magnitude, geographical extent, frequency, and reversibility; however, the effect has low confidence because the Project interaction with Clark's nutcracker is not well understood (**Section 5.4.9**). The effects will occur during the construction phase, and these effects will be evident in the closure and post-closure phases.

5.4.6.3.7 Indicator 1: Whitebark Pine

Whitebark pine (*Pinus albicaulis*) was the only upland plant species at risk encountered during field surveys in the Project area. Whitebark pine's conservation status was listed as Endangered by COSEWIC in 2010, and added to Schedule 1 of the *SARA* in July 2012. The Province of BC Blue-lists whitebark pine and it was ranked as S2S3 (i.e., status imperiled to vulnerable) in March of 2013 (BC CDC, 2013). Whitebark pine is a keystone species in subalpine ecosystems, because a large number of plants and wildlife depend upon its existence (Barringer, 2012; Smith et al, 2012). This pine is a slow-growing but hardy subalpine conifer that tolerates poor soils, steep slopes, and windy exposures (Clason, 2013).

Whitebark pine is declining nearly range-wide from a combination of several threats, including white pine blister rust, MBP, fire exclusion, and climate changes (Barringer, 2012; COSEWIC, 2010; Smith 2012).

White pine blister rust is an introduced fungus that infects and kills otherwise healthy trees. The extent of white pine blister rust depends not only on the distribution of whitebark pine but also on that of its alternate hosts, native currant and gooseberry shrubs (*Ribes spp*.). Besides mortality, infected trees can also experience top kill. Most of the cone production occurs at the top portion of the tree, therefore top-killed trees experience a reduction or prevention of seed production (COSEWIC, 2010).

Mountain pine beetle attacks have occurred historically; however, epidemic population levels recently have spread to much of the whitebark pine range in BC. Typically, the majority of mature whitebark pine trees in a stand will be killed (COSEWIC, 2010). The white pine blister rust infection increases the likelihood and severity of MBP attack.

Successional replacement by shade-tolerant competitors following fire exclusion has threatened whitebark pine. Fire is the primary disturbance regime by which whitebark pine regenerates throughout most of its range (COSWEC, 2010). Fire exclusion, which includes both fire prevention and suppression, result in a decrease in early seral habitat. Whitebark pine requires open ground to successfully germinate and survive, so with decreased fires at high elevations there is less opportunity for whitebark pine regeneration across its range.

Climate change also threatens whitebark pine, because of increasing MBP populations, and because other tree species can survive at higher elevations and compete with whitebark pine. The increased competition will reduce suitable sites for seedling establishment and increase stress on mature trees, resulting in reduced seed production and increased susceptibility to White pine blister rust and MBP (COSWEC, 2010).

The Project's effect assessment for whitebark pine combined Project baseline data with those collected by Clason and Moody for the whitebark pine management plan. The latter was a multi-year program to determine the extent and condition of the whitebark pine population at and around Mt. Davidson, as well as to provide mitigation and management to facilitate long-term viability of the population.

Clason and Moody (2013) estimated, based on field surveys, the distribution of whitebark pine on Mt. Davidson to extend across approximately 1,057 ha, of which 341 ha (32 %) occur in the LSA. **Figure 5.4.6-1** shows the mapped distribution in relation to the LSA and RSA and the potential effects.

5.4.6.3.7.1 Ecosystem Loss

The dominant effect on whitebark pine will be direct ecosystem loss because of site clearing and grading for the construction of mine site facilities (e.g., TSF, open pit, waste rock dump, haul roads, buildings, laydown, construction sites, processing plant, etc.). Project activities in the mine site are expected to remove 114 ha (33%) of the whitebark pine population in the LSA during the Project Case (i.e., maximum disturbance).

Post-closure Case there will be a permanent loss of 114 ha. The open pit will remove 41 ha of the whitebark pine population. Other areas reclaimed will be reclaimed to upland forest and not to the original baseline ecosystems originally supporting whitebark pine. The level of certainty in reclaiming to baseline condition is very low for an ecosystem supporting a SARA-listed species such as whitebark pine. Therefore, the loss of 114 ha of baseline whitebark pine is considered a permanent loss in the assessment. This corresponds to an 11% reduction in overall whitebark pine, given that the total Mt. Davidson population is 1,057 ha

5.4.6.3.7.2 Dust Deposition

Out of 341 ha of whitebark pine area in the LSA, a total of 27 ha (8%) of the population will be impacted by dust deposition during the Project Case. Dust levels throughout the mine footprint will be high, and may exceed ambient air-quality emissions standards (Air Quality, **Section 5.2.4**). As described in **Section 5.4.6.3.6.2** dust may decrease the ability of whitebark pine trees to conduct photosynthesis, by filling stomata (related species, *Pinus cembra*: Minarcic and Kubicek 1991 in Weaver 2001), affect respiration and transpiration, and allow the penetration of phytotoxic gaseous pollutants, eventually reducing plant growth and density.

5.4.6.3.7.3 Spread of Invasive Plants

No invasive plants were recorded that overlapped the whitebark pine area. However, invasive plants were recorded at lower elevations along the road and transmission line corridor. Vegetation clearing and soil disturbance during construction may result in the introduction and ultimately the spread of invasive plants. Combined with a possible increase in soil N, the proliferation of invasive plants is a potential environmental effect. Whitebark pine is a seral and shade-intolerant species, it regenerates well on open sites. An increase in vegetation, particularly invasive plants, could lead to a reduction of whitebark pine seedling survival.

5.4.6.3.7.4 Nitrogen Deposition

Out of 341 ha of whitebark pine in the LSA, 14 ha (4%) occurs southeast of the mine site, where N deposition is predicted to exceed the 5 kg/ha^{-1}/yr^{-1} threshold. As described in **Section 5.4.6.3.3.4**, excess N may affect whitebark pine by giving other plant species a competitive advantage, and/or increasing susceptibility to insects, disease (e.g., white pine blister rust and MBP), blowdown, and/or drought stress. Nitrogen deposition may reduce key ectomycorrhizal fungal species that may be associated with the whitebark pine, most of which are often important for drought and root-pathogen resistance (Keane et al., 2011, Lilleskov, 2002). Nitrogen deposition may lead to a change in allocation of carbohydrates from roots to shoots, resulting in smaller root systems, making the whitebark pine in the affected area more susceptible to blowdown or drought stress. Grulke et al. (1998) discuss reduced root biomass on ponderosa pine (*Pinus ponderosa*).

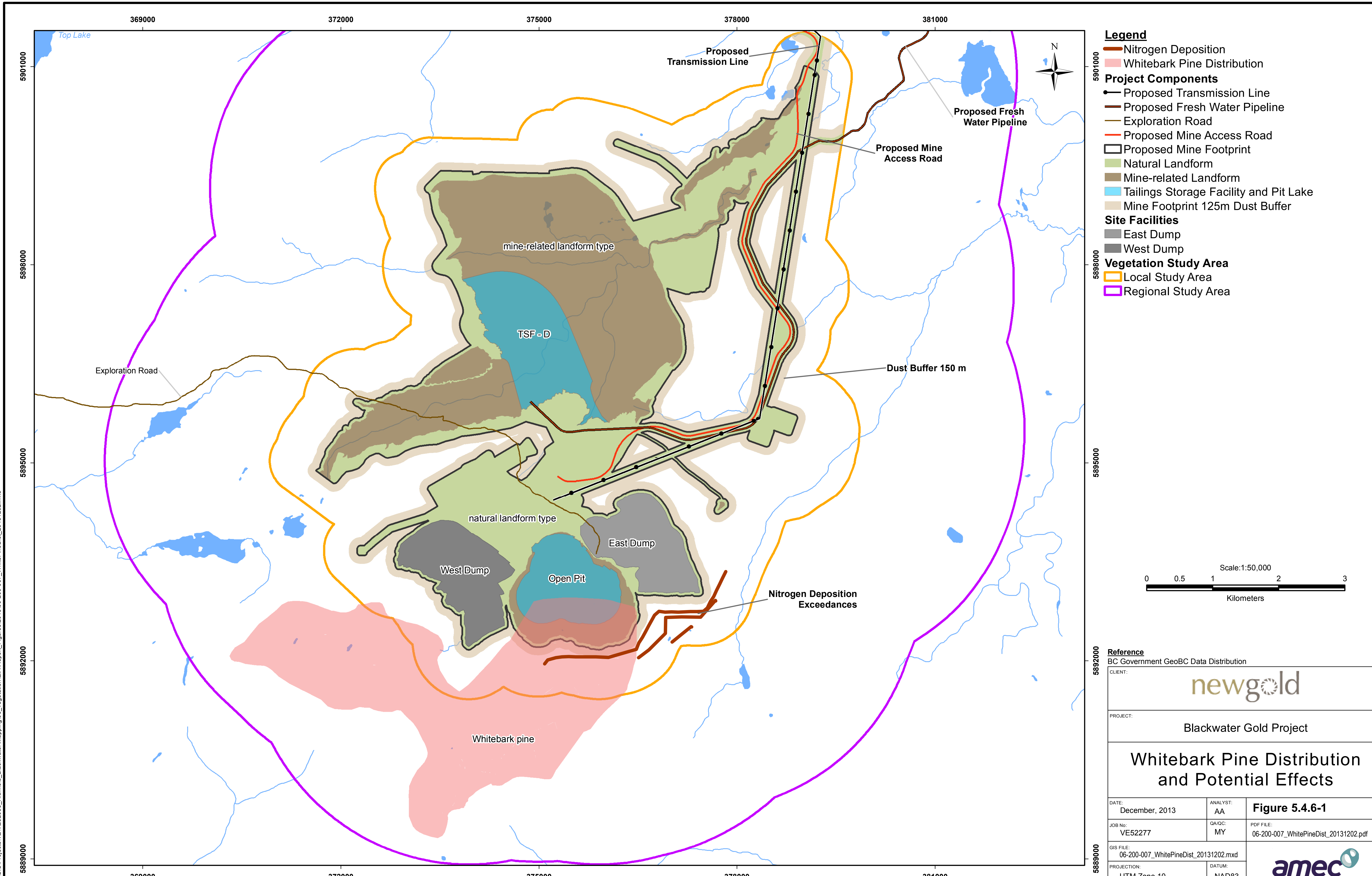
5.4.6.3.7.5 Whitebark Pine Regeneration

Whitebark pine is almost entirely dependent on Clark's nutcracker for seed dispersal and regeneration (Hutchins and Lanner, 1982). Clark's nutcrackers are forest birds that have developed a mutualistic relationship with the whitebark pine. They feed on only a handful of other conifer species, of which there are none in the Project area, with the possible exception of the occasional Douglas-fir (*Pseudotsuga menziessii*) along the transmission line or Kluskus FSR. Due to the importance of these conifer seeds for food and reproduction, the nutcracker's range across BC mirrors the range of those conifer species (refer to Forest and Grassland Birds VC, **Section 5.4.9**).

Population sizes of whitebark pine and Clark's nutcracker are closely correlated. Without mitigation, Clark's nutcracker numbers may decline in response to whitebark pine loss. This effect will likely continue until comparable stands of whitebark pine are re-established. Whitebark pine is very slow growing, often taking between 40 and 80 years before cones are produced in sufficient quantities for effective reproduction and ecosystem functions. There are no data on a population threshold for sustaining Clark's nutcracker numbers. However, based on observations of existing birds (approximately 5 to 10 pairs, **Section 5.4.9**), and evidence that all available cones were harvested (presumably by other species as well as Clark's nutcracker) in 2013; numbers may decline further with future reductions in the whitebark pine population.

Prevalence of white pine blister rust has a compounding effect. Following standard blister rust survey methods (Tomback et al., 2005) Clason and Moody (2013) recorded the number of trees infected with active or inactive rust in the branch or stem from 2012 (36%, n=100) and 2013 (28%, n=125), for an average infection rate of 32% for the two years.

In summary, for reasons metioned above a reduction of whitebark pine trees could lead to fewer Clark's nutcrackers, which in turn could reduce seed dispersal, germination, and regeneration of the Mt. Davidson whitebark pine population.



Legend
Nitrogen Deposition
Whitebark Pine Distribution
Project Components
Proposed Transmission Line
Proposed Fresh Water Pipeline
Exploration Road
Proposed Mine Access Road
Proposed Mine Footprint
Natural Landform
Mine-related Landform
Tailings Storage Facility and Pit Lake
Mine Footprint 125m Dust Buffer
Site Facilities
East Dump
West Dump
Vegetation Study Area
Local Study Area
Regional Study Area
Top Lake
Proposed Transmission Line
Proposed Fresh Water Pipeline
Proposed Mine Access Road
mine-related landform type
TSF - D
Exploration Road
Dust Buffer 150 m
natural landform type
East Dump
West Dump
Open Pit
Nitrogen Deposition Exceedances
Whitebark pine
N
369000
372000
375000
378000
381000
5901000
5898000
5895000
5892000
5889000
Scale:1:50,000
0 0.5 1 2 3
Kilometers
Reference
BC Government GeoBC Data Distribution
CLIENT:
newgold
PROJECT:
Blackwater Gold Project
Whitebark Pine Distribution and Potential Effects
DATE: December, 2013
ANALYST: AA
Figure 5.4.6-1
JOB No: VE52277
QA/QC: MY
PDF FILE: 06-200-007_WhitePineDist_20131202.pdf
GIS FILE: 06-200-007_WhitePineDist_20131202.mxd
PROJECTION: UTM Zone 10
DATUM: NAD83
amec
Y:\GIS\Projects\VE\VE52095_Richfield_Blackwater\Mapping\06_vegetation\EIA\Report_Figures\2013\06-200-007_WhitePineDist_20131202.mxd

5.4.6.3.7.6 Mitigation

A brief summary of mitigation measures applicable to reducing whitebark pine loss and other effects begins below. Other EA report sections or management plans provide details: Whitebark Pine 5 Year Management Plan (Clason and Moody 2014), Forest and Grassland Birds VC (**Section 5.4.9**), RCP (**Section 2.6**), Air Quality and Emissions Management Plan (**Section 12.2.1.18.4.9**), Transportation and Access Management Plan (**Section 12.2.1.18.4.14**), Sediment and Erosion Control Plan (**Section 12.2.1.18.4.1**), LSVMRP (**Section 12.2.1.18.4.4**), the ISMP (**Section 12.2.1.18.4.5**), and Wildlife Management Plan (**Section 12.2.1.18.4.6**).A Whitebark Pine Management Plan will be developed and submitted to BC MOE and designated Aboriginal groups prior to clearing in whitebark pine habitat. The Whitebark Pine Management Plan will be implemented and process reported at least every three years to the BC MOE and designated Aboriginal groups in consultation with applicable regulatory authorities.

5.4.6.3.7.6.1 Ecosystem Loss Mitigation

Mitigation proposed for whitebark pine is a blend of approaches aimed at offsetting the loss of trees at the site while supporting provincial initiatives to support the species. This takes into account the conservation status of the tree as well as its biology for slow maturation and its inability to compete with other tree species as it is a relatively shade-intolerant tree. Threats to whitebark pine extend beyond project related effects including blister rust, climate change and mountain pine beetle. Therefore mitigation will include a range of strategies including avoiding loss through project design, replanting, progressive reclamation and supporting research. Further discussion with regulatory agencies is anticipated to refine the research components to ensure the maximum benefit is derived from the work.

Commitments include: increasing awareness, population inventory, rust screening, cone collection, reclamation trials, off-site transplanting and stand enhancement. Monitoring will be on-going through the life of the mine.

5.4.6.3.7.6.1.1 Awareness

For workers involved with project components and activities likely to have potential for effecting white bark pine (e.g., land clearing and waste dump construction) a specific orientation will be conducted. The Proponent initiated this approach during exploration activities and will continue the practice through the mine life. The orientation program will support mitigation actions to identify and protect/transplant individual trees during clearing, as well as ensure awareness of the importance of other mitigation actions as they are implemented (e.g., reclamation trials).

5.4.6.3.7.6.1.2 Population inventory

As part of baseline studies the extent of white bark pine was delineated and transects were conducted to support an estimate of stem density, tree health (level of rust infection) and extent of population. During construction, an inventory following standards identified by the whitebark pine committee will be conducted on the mine site prior to overburden stripping. Areas of potential non-direct effects (e.g., dust deposition) and areas where other mitigation might be applied (e.g., cone collection, transplanting or stand enhancement) will also be identified and inventoried. The inventory will include transects to assess tree health and identify the level of infection by blister rust. The white bark pine population inventory results will include estimates of rust infection rates in white bark pine near Mt. Davidson. On-site inventories are expected to be updated every 3-5 years throughout mine operations.

5.4.6.3.7.6.1.3 Rust Screening

Rust screening is clearly defined and outlined in the 5 Year Management Plan for the exploration phase developed by Moody and Clason, 2014. The 5-year plan identifies various approaches to rust screening which should be adhered to during the operation and closure phase of the mine. Essentially the identification of rust resistant trees is a multi-step process.

Commitment to support research into other factors affecting the viability of whitebark pine during the Project's construction and operations phases is essential. There are a number of approaches to rust screening to obtain an effective and applicable screening program aligned with provincial priorities. The Proponent will work with regulatory agencies and First Nations in supporting research initiatives related to rust screening.

Rust screening typically involves blister rust transect surveys within the extent of the Mt. Davidson whitebark pine population. Cones will be collected from phenotypically rust resistant parent trees that occur a minimum of 50 m apart. The target for rust screening is a minimum of 50 seedlings from 100 trees. Following cone collection a portion of seeds will be submitted to various research facilities to conduct further rust screening. The remaining portion of seeds collected from the apparent rust resistant trees will be germinated in a nursery to produce transplants. Excess seed will be stored at the BC Ministry of Forests, Lands and Natural Resource Operations Surrey Seed Centre.

On-going visual monitoring of newly planted areas on-site will occur every five years to assess the success of seedling establishment and overall health of each tree. All parent trees involved in this process are permanently marked to facilitate future seed collections should their progeny demonstrate rust resistance. The majority of healthy parent trees will not produce rust resistant seedlings. Further detail and literature review is provided in White Pine Blister Rust Screening for Whitebark Pine (available upon request).

5.4.6.3.7.6.1.4 Cone Collection and Seedling Propagation

The mechanisms controlling cone production and masting by whitebark pine are not well known and prediction of cone production greater than 1 year in advance is not possible. Given the time required for trees to mature and produce cones (>40 years), cone collection was initiated by the Proponent in 2012. To date, cone collection has been successful in 2013, although 2014 is expected to be a 'good cone year' as first year conelets were observed in 2013. Based on 50% germination for approximately 4 kg of collected seed, 1500 seedlings are expected to be produced from cone collection in 2013. Seedling propagation will consist of germinating seeds within a nursery, which will be grown for a minimum of 2 years.

To guide seed collection, seedling targets for all activities will be developed. Cone collection and seedling propagation will be conducted to support planting, progressive reclamation and rust screening activities. Planting includes planting in 2016 the seedlings to be grown from seed collected in 2013. Planting will focus on upslope areas from the mine site that contain ESSFmv1 and ESSFmv1p. Progressive reclamation activities in year 8 of operations for the west waste rock dump and open pit slopes will require cone collection be initiated at least 3 years prior. Blister rust screening will require enough seed to grow 50 seedlings from 100 parent trees at a minimum spacing of 50 m. Once seedlings are produced and planted (2 – year old stock) these trees will be monitored each year with re-measurement every 5 years.

Cone collection will occur opportunistically in mast years during the construction and operations phases to support these three activities. Annual inspection for the evidence of conelets will support identification of masting years.

5.4.6.3.7.6.1.5 Reclamation Trials and Progressive Reclamation

Reclamation trials using whitebark pine seedlings will be undertaken during progressive reclamation stages to develop expertise in using whitebark pine during the final reclamation phases. Whitebark pine occurs naturally on very rocky sites including what appear to be old exploration roads on Mount Davidson. Although observations of whitebark pine in coarse, poor substrates are common, reclamation trials will be structured to maximize survival and growth of seedlings. Trials will include:

- **Substrate Trials** – Trials will require the use of different substrates to identify which substrates are best suited to whitebark pine restoration. Using whitebark pine for reclamation is still in an early research and developmental stage, and it is unclear if plantings within difficult substrates, such as those created during mining activities, will be successful. Transplanting success of individual trees that would otherwise be cleared from the open pit area will provide information on substrate conditions that could be successful for the reclamation of areas using whitebark pine (e.g., west waste rock dump and overburden slope of the open pit). If sufficient individual trees cannot be transplanted to adequately assess the different substrates being tested, then planting will be supplemented with seedlings from cones collected in 2013/14, which are anticipated to be planted in 2016/17; and
- **Mycorrhizal Fungi Trials** – Whitebark pine relies on various species of mycorrhizal fungi (Mohatt et al. 2008). The use of mycorrhizae is a typical nursery practice to improve seedling growth. Inoculating seedlings may be as simple as adding native, inoculated soil collected from areas where whitebark pine naturally occurs. Mycorrhzal inoculation of seedlings should be conducted either wholly or as a part of a paired trial to determine the efficacy of this treatment (inoculated vs. non-inoculated). Where seedlings are available, mycorrhizal fungi trails will be conducted concurrently with other trials e.g., substrate trials where seedlings are planted as part of reclamation research prior to final reclamation.

Progressive reclamation for whitebark pine will occur on the west waste rock dump and the open pit. The east and west waste rock dumps as described in the Reclamation and Closure Plan **Section 2.6** were identified as potentially for whitebark pine reclamation due to their location and spatial elevation within the landscape. The elevation is similar to their naturally occurring elevation on Mt. Davidson. The west waste rock dump is approximately 172 ha. In year 8 of operations it is predicted to be 75% overburden and is expected to be suitable for planting with whitebark pine. The west dump is considered to be more suitable than the east waste rock dump because the overburden is thicker and soils in the east waste rock dump are intended for reclamation of other areas, which restricts the timing of progressive reclamation for long lived species such as whitebark pine. The open pit will be developed with an overburden slope (slope angle 20 degrees) on the east side, which would allow for an additional 30 ha, approximately, that could be planted with whitebark pine part way through the operations phase. Planting will need to carefully planned and executed to maintain a safe work environment.

Site contouring and preparation will create suitable microsites thus increasing the chances of transplanting success. Site contouring will be proactive and progressive using the available waste rock. The new landforms must be stable, benched, preferably south facing and designed to convey water to natural constructed watercourses and waterbodies.

Monitoring of reclamation trials and progressive reclamation success will be concurrent with any updates to the reclamation plan for the site. It is anticipated the reclamation plan will be updated during project permitting and through the mine life as the mine plan develops. At this time, white bark pine monitoring is proposed to be conducted 1 year after planting and then every 3-5 years. However, successful reestablishment of whitebark pine may be limited by factors beyond the control of the Proponent. The Proponent support for research into these factors affecting the species (e.g., blister rust screening, and data on tree health documenting blister rust infection levels) as well as activities such as transplanting, cone collection and reclamation trials all support reaching the end land use objectives for this species.

5.4.6.3.7.6.1.6 Off-Site Transplanting

The Proponent initiated off-site transplanting during exploration activities and will continue the practice through the mine life. Using results from the population inventory, individual plants/trees will be relocated to prevent loss. However, this will be limited by the ability to physically move individual specimens, the presence of suitable transplant relocations, the health of the specimen (i.e., no sign of blister rust), and approval of applicable permits. Individuals will only be moved if they show no sign of blister rust.

Transplanting will occur at the time of land clearing during construction and operations so as to avoid unnecessary disturbance if land clearing is not conducted. Associated with exploration some transplants have occurred; results of these transplants will be used to support transplant success. Factors potentially affecting transplant success will be sampled at the time of transplant.

The identification of locations to which individuals or groups of individuals may be transplanted to will be determined through the Mt. Davidson whitebark pine population inventory. Subsequent monitoring will be concurrent with the timing of ongoing population inventories (i.e., every 3 – 5 years throughout operations) with the intention that results will guide reclamation trails and planting of seedlings.

5.4.6.3.7.6.1.7 Stand Enhancement

Stand enhancement is a mitigation option designed to improve conditions for white bark pine survival and recruitment. If applied, stand enhancement will include (1) the creation of openings to support the caching of seed by Clarks nutcracker and (2) the removal of competing vegetation (e.g., shade tolerant species) around white bark pine trees. If prescribed, this option will consider managing fire risk given its potential for increasing fuel.

The use of stand enhancement as a mitigation option will be based on the results of future inventories and the success of the reclamation trials and progressive reclamation. If implemented, the timing of stand enhancement will follow an updated inventory and may be concurrent with the creation of access to support other mitigation (e.g., transplanting). Tree clearing as part of stand enhancement is subject to permit approval, including referral to First Nations.

5.4.6.3.7.6.2 Dust Mitigation

Most dust emissions occur from vehicle travel on non-paved roads (e.g., mine haul roads), and from materials handling (bulldozers, graders, truck dumping) (refer to Air Quality, **Section 5.2.4**). Dust effects will be mitigated using a combination of administrative, design, and emission control strategies:

- Administrative: road dust emissions are directly related to vehicle speed, which will be controlled throughout the mine site;
- Design: road dust emissions are directly related to road silt content, and haul road surfaces will be constructed of coarse aggregate with very low silt content;
- Control: unpaved road surfaces will be wetted as needed to control dust emissions when conditions are not wet or frozen, and the wetting agent may include a chemical to extend and improve dust control over using water alone. The specific chemical has not yet been selected, and it is anticipated that a number of chemicals will be tried to ensure optimum performance. This is common practice at mine sites, and chemical selection will be informed by experiences at other mines in similar climate. Wetting with dust suppressant chemical addition is anticipated to reduce road dust emission by 90%; and
- Control: materials handling (dumping, bulldozing, grading) generates PM emissions, and wetting of the material before handling dramatically reduces PM emissions. Much of the material coming from the pit is saturated as it is excavated from below the water table and a 50% reduction in material handling PM emissions is anticipated due to material wetting prior to handling.

5.4.6.3.7.6.3 Spread of Invasive Plant Mitigation

The proximity of whitebark pine to the mine site (i.e., disturbed area) and high N levels may facilitate invasive plant proliferation. The spread of invasive plants will be mitigated through the implementation of the ISMP (**Section 12.2.1.18.4.5**), which includes the following BMPs:

- Early detection and rapid response (EDRR)—determine the priority invasive plant species within the operating area, and maintain awareness of species new to the area;
- Implement the ISMP (**Section 12.2.1.18.4.5**) to control any invasive plant colonizing the mine site Project component; and
- Monitor and apply appropriate control measures as described in the ISMP (**Section 12.2.1.18.4.5**).

5.4.6.3.7.6.4 Nitrogen Deposition Mitigation

Implement emissions measures as described in the Air Quality and Emissions Management Plan (AQEMP) (**Section 12.2.1.18.4.9**), including:

- Reducing vehicle emissions by enforcing speed limits, by fuel selection, use of vehicles that meet emission standards, and vehicle and equipment maintenance;
- Ensuring the incinerator and other sources of emissions meet all relevant Canadian emission requirements; and
- Limit vehicle and equipment idling.

5.4.6.3.7.6.5 Whitebark Pine Regeneration Mitigation

A reduction in whitebark pine trees could lead to fewer Clark’s nutcrackers, which means less seed dispersal, less germination, and possibly less regeneration. Mitigation will consist of reclaiming the whitebark pine trees lost, as well as measures aimed at maintaining the existing population of Clark’s nutcracker in the area, discussed in more detail in the wildlife section (**Section 5.4.9**). Mitigation will include satellite tagging Clark's nutcracker to determine habitat usage and dispersal range, and supplemental feeding after mine operations and during reclamation until trees mature and produce sufficient seeds.

5.4.6.3.7.6.6 Monitoring

Given the uncertainty associated with methods for reclaiming whitebark pine, adaptive monitoring is required. The whitebark pine population in, and potentially adjacent to the LSA, is predicted to experience population decline as a result of direct removal, habitat degradation from dust and N deposition, and/or reduced seed dispersal because of potential lower Clark’s nutcracker numbers. The effects of these influences on the whitebark pine population are currently too complex to allow reliable predictions. Therefore, it is essential that the entire population of whitebark pine in the LSA and RSA be assessed for health and monitored for changes. If effects are observed, practices to minimize those effects will be initiated and monitored for effectiveness.

Monitoring will include:

- The number of dead and live whitebark pine trees;
- Condition of whitebark pine trees—i.e., crown condition, stem structure, broken tops, multiple stems, bushy growth, yellow needles, etc.;
- Mensuration data such as diameter, height, and age; and
- Transect surveys to determine the number of trees affected by mountain pine beetle and white pine blister rust.

5.4.6.3.7.6.7 Effectiveness of Mitigation

Table 5.4.6-4 provides ratings for effectiveness of mitigation measures to avoid or reduce potential effects on whitebark pine during mine site development. A Whitebark Pine Management Plan will be developed and submitted to BC MOE and designated Aboriginal groups prior to clearing in whitebark pine habitat. The Whitebark Pine Management Plan will be implemented and process reported at least every three years to the BC MOE and designated Aboriginal groups in consultation with applicable regulatory authorities. Mitigation measures will be based on site-specific information and construction engineering and are therefore preliminary at this stage.

Table 5.4.6-4: Mitigation Measures and Effectiveness of Mitigation to Avoid or Reduce Potential Effects on Whitebark Pine during Mine Site Development

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
Ecosystem loss	Construction, Operations, Closure, Post-closure	For workers involved with project components and activities likely to have potential for effecting white bark pine (e.g., land clearing and waste dump construction) a specific orientation will be conducted. The orientation program will support mitigation actions to identify and protect/transplant individual trees during clearing, as well as ensure awareness of the importance of other mitigation actions as they are implemented (e.g., reclamation trials)	Moderate
		Off-site transplanting will continue through the mine life	Low
		Stand enhancement will include (1) the creation of openings to support the caching of seed by Clarks nutcracker and (2) the removal of competing vegetation (e.g., shade tolerant species) around white bark pine trees	Moderate
	Construction, Operations	Inventory, following standards identified by the whitebark pine committee, will be conducted on the mine site prior to overburden stripping	Moderate
		Rust screening surveys	Moderate
		On-going visual monitoring of newly planted areas on-site will occur every five years to assess the success of seedling establishment and overall health of each tree	Moderate

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
		Cone collection and seedling propagation will be conducted to support planting, progressive reclamation and rust screening activities	Moderate
	Closure	Reclamation trials using whitebark pine seedlings will be undertaken during progressive reclamation stages to develop expertise in using whitebark pine during the final reclamation phases	Moderate
Dust deposition	Construction, Operations, Closure, Post-closure	Vehicle speed will be controlled throughout the mine site as described in the TAMP (**Section 12.2.1.18.4.14**)	High
		Haul road surfaces will be constructed of coarse aggregate with very low silt content	High
		Unpaved road surfaces will be wetted as needed to control dust emissions when conditions are not wet or frozen, and the wetting agent may include a chemical to extend and improve dust control over using water alone	High
		Materials will be wetted prior to handling	High
Spread of invasive plants	Construction, Operations, Closure, Post-closure	EDRR—determine the priority invasive plant species within the operating area, and maintain awareness of species new to the area	Moderate
		Implement the ISMP (**Section 12.2.1.18.4.5**) to control any invasive plant colonizing the mine site Project component	Moderate
		Monitor and apply appropriate control measures as described in the ISMP (**Section 12.2.1.18.4.5**)	Moderate
Nitrogen deposition	Construction, Operations, Closure, Post-closure	Reducing vehicle emissions through enforcing speed limits, fuel selection, using vehicles that meet emission standards, and regular vehicle and equipment maintenance as described in the AQEMP (**Section 12.2.1.18.4.9**)	Moderate
		Ensuring the incinerator and other emissions sources meet all relevant Canadian emission requirements	Moderate
		Limiting vehicle and equipment idling	Moderate
Whitebark pine regeneration	Construction, Operations, Closure, Post-closure	Reclaiming the whitebark pine trees lost, as well as measures aimed at maintaining the existing population of Clark's nutcracker in the area, discussed in more detail in the wildlife section (**Section 5.4.9**). Mitigation will include satellite tagging Clark's nutcracker to determine habitat usage and dispersal range, and supplemental feeding after mine operations and during reclamation until trees mature and produce sufficient seeds	Low
		Implement the ISMP (**Section 12.2.1.18.4.5**) to control any invasive plant colonizing the mine site Project component	Low
		Monitor and apply appropriate control measures as described in the ISMP (**Section 12.2.1.18.4.5**)	Low

Note: AQEMP = Air Quality and Emissions Management Plan; EDRR = early detection and rapid response; ISMP = Invasive Species Management Plan; TAMP = Transportation and Access Management Plan

The mitigation success ratings shown in **Table 5.4.6-4** are incorporated into the confidence ratings defined in **Section 4.3.5** and summarized in **Table 5.4.6-16**, **Table 5.4.6-17**, and **Table 5.4.6-18**. In summary, low success rating means mitigation has not been proven successful, moderate success rating means mitigation has been proven successful elsewhere, and high success rating means mitigation has been proven effective.

The mitigation success of ecosystem loss is rated moderate overall because reclamation success has been proven successful elsewhere; however, there is a level of uncertainty because mitigation success takes into account conservation status of the tree as well as its biology for slow maturation and inability to compete with other tree species since it is a relatively shade-intolerant tree. Threats to whitebark pine extend beyond project-related effects including blister rust, climate change, and mountain pine beetle.

The mitigation success of dust deposition is rated high overall because mitigation measures such as dust suppression techniques have proven successful. The mitigation success of nitrogen deposition is rated moderate overall because mitigation measures will reduce the overall amount of nitrogen deposition. However, the effect is considered long term, as it is uncertain how long excess nitrogen will persist in affected areas. The mitigation success of spreading invasive plants is rated moderate overall because mitigation measures are consistent with BMPs identified by the Invasive Species Council of BC and BC MFLNRO, which have shown success in other areas. The mitigation success of whitebark pine regeneration is rate low overall because this type of mitigation has not been proven successful and the response of Clark's nutcrackers to reduced whitebark pine numbers is likely negative (Barringer, 2012). The potential effects of whitebark pine regeneration cannot be quantified at this time, and therefore the significance ranking is based on qualitative information and expert opinion (Barringer et al., 2012; Clason, 2013, Clason and Moody, 2013; Hutchins, 1982; Keane et al., 2011; McKinney, 2009; Schwandt, 2010; Tomback, 2005).

5.4.6.3.8 Indicator 2: Potential Plant Species-at-Risk Habitat

To determine the potential effects on plant species at risk, the location of plant species at risk was mapped and superimposed with the project activities and development. Ecosystems were ranked and were concluded to be all ranked equally able to support potentially occurring plant species at risk. Scientifically determining the probability (e.g. high, medium and low) that one or more plant species at risk occurs in the project area requires a niche modelling approach (De Queiroz, 2007); however, this approach was well beyond the scope of this project. As a result the conservative approach was taken in that any ecosystem deemed to have suitable habitat to support a plant species at risk was equal in its ability to support any plant species at risk. It was judged that if an ecosystem had the habitat features to support more than one species at risk, it should not be ranked higher than those ecosystems that could support only one plant species at risk. Therefore the approach taken was to conduct a thorough review of the potentially occurring plant species at risk to determine if they could occur in the Project area. This review resulted in reducing the list of 159 potentially occurring plant species to 10. These 10 were deemed to have the highest potential to occur in the study area based on their habitat requirements. With this approach an ecosystem unit either has or does not have the ecological features to support one of the 10 plant species at risk, i.e. those with the right ecological conditions were scored a 1 and those without were scored a 0. The area (ha) of ecosystem with the ability to support a plant species at risk was calculated pre and post – case scenarios to determine the effects of the project.

The short list of the 10 potentially occurring plant species at risk was correlated to BGC site series (**Table 5.4.6-5**). In total, 33 site series were identified as having the ability to support one or more potentially occurring plant species at risk. Site series with the ability to support a potentially occurring plant species at risk were equally ranked (**Table 5.4.6-5**). The baseline ecosystem map (**Appendix 5.1.3.4**, Annex 3) shows the distribution of these ecosystems.

Table 5.4.6-5: Ecosystems with Ability to Support One or More Potentially Occurring Plant Species at-Risk – All ecosystems are ranked equal

BGC Unit	Site Series	Map Code	Site Series Name
SBSdk	81	SW	Saskatoon–Slender wheatgrass
SBSdk	82	BW	Bluegrass–Slender wheatgrass
SBSdk	02	LJ	Lodgepole pine–Juniper–Ricegrass
SBSdk	03	LC	Lodgepole pine–Feather moss–Cladina
SBSdk	04	DS	Douglas fir–Soopolallie–Feather moss
SBSdk	06	ST	Hybrid white spruce–Twinberry–Coltsfoot
SBSdk	08	CD	Black cottonwood–Dogwood–Prickly rose
SBSdk	00	Fl05	Drummond's willow–Bluejoint
SBSdw3	81	SW	Saskatoon–Slender wheatgrass
SBSdw3	82	BW	Bluegrass–Slender wheatgrass
SBSdw3	02	DC	Douglas-fir–Lodgepole pine–Cladonia
SBSdw3	03	LC	Lodgepole pine–Feather moss–Cladina
SBSdw3	04	SR	Hybrid white spruce–Douglas-fir–Ricegrass
SBSdw3	00	Fl05	Drummond's willow–Bluejoint
SBSmc2	02	PH	Lodgepole pine–Huckleberry–Cladonia
SBSmc2	04	HB	Hybrid white spruce–Huckleberry–Dwarf blueberry
SBSmc2	05	TC	Hybrid white spruce–Twinberry–Coltsfoot
SBSmc2	10	SH	Hybrid white spruce–Horsetail
SBSmc3	02	LJ	Lodgepole pine–Juniper–Dwarf huckleberry
SBSmc3	03	LF	Lodgepole pine–Feathermoss–Cladina
SBSmc3	04	SS	Hybrid white spruce–Huckleberry–Soopolallie
SBSmc3	07	ST	Hybrid white spruce–Twinberry
ESSFmv1	04	FG	Subalpine fir–Huckleberry–Gooseberry
ESSFmv1	00	VG	Sitka valerian–globeflower moist meadow
ESSFxvp1	00	FH	Subalpine fir–Indian Hellebore
ESSFxvp1	00	KC	Kinnikinnick–Cladonia
ESSFxvp1	00	VG	Sitka valerian–globeflower moist meadow
BAFAun	00	FW	Altai fescue–Dwarf willow
BAFAun	00	WM	Wet seepage meadow

BGC Unit	Site Series	Map Code	Site Series Name
Anthropogenic, Sparsely Vegetated, & Nonvegetated	00	ES	Exposed Soil
Anthropogenic, Sparsely Vegetated, & Nonvegetated	00	MN	Moraine
Anthropogenic, Sparsely Vegetated, & Nonvegetated	00	RO	Rock Outcrop
Anthropogenic, Sparsely Vegetated, & Nonvegetated	00	TA	Talus

Note: BGC = Biogeoclimatic, SBSdk = Dry Cool Sub-Boreal Spruce, SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant, SBSmc2 = Babine Moist Cold Sub-Boreal Spruce variant; SBSmc3 = Kluskus Moist Cold Sub-Boreal Spruce variant; ESSFmv1 = Nechako Very Cold Engelmann Spruce Subalpine Fir variant; ESSFmv1p = Nechako Very Cold Engelmann Spruce-Subalpine Fir Parkland variant

5.4.6.3.8.1 Ecosystem Loss

5.4.6.3.8.1.1 Mine Site

A total of 1,415 ha of potential plant species-at-risk habitat occurs in the Project area mine site (**Table 5.4.6-6**). During the Project case, maximum disturbance 765 ha (54%) to potential habitat will occur. The largest area affected is in the SBSmc3 Lodgepole pine–Feather moss–Cladina (03/LF) with 366 ha (60%) impacted. The ESSFmv1, Subalpine fir–Huckleberry–Gooseberry (04/FG) will lose 265 ha (49%).

Post-closure, after reclamation, habitat for plant species at risk occurring on natural landforms types (330 ha) will be restored to conditions similar to baseline ecosystems, provided reclamation and mitigation measures are implemented. Following reclamation, 435 ha (31%) of potential plant species-at-risk habitat occurring on mine-related landforms will differ substantially from baseline condition (i.e., open pit, tailings storage facility, and waste rock piles) and will be considered a permanent and irreversible loss.

5.4.6.3.8.1.2 Linear Components

Linear components include the mine site access road, freshwater supply pipeline, airstrip, transmission line, and Kluskus FSR. During the Project case a total of 155 ha (9%) of 1,796 ha of potential species-at-risk habitat will be affected by Project activities (**Table 5.4.6-7**). Most of these effects will occur in the SBSdk Hybrid white spruce–Twinberry–Coltsfoot (06/ST) ecosystem (55 ha, 11%). The next largest area impacted will be in the SBSmc3 Lodgepole pine–Feathermoss–Cladina (03/LF) ecosystem (25 ha, 10%).

Post-closure, after reclamation, a total of 8 ha (<1%) will not be restored to baseline condition. This is due either to permanent road construction along the proposed mine site access road, or as a result of ecosystems at risk. The latter cannot be reclaimed with any certainty, therefore any loss of ecosystems at risk is considered a permanent one.

Table 5.4.6-6: Potential Plant Species-at-Risk Habitat: Mine Site Effects on Ecosystem Loss in the LSA

BGC Unit	Site Series Name	Site Series	Map Code	Baseline Case (ha)	Project Case			Post-Closure Case		
					Remaining (ha)	Area Change (ha)	Percent Change (%)	Remaining and Reclaimed (ha)	Area Change (ha)	Percent Change (%)
SBSmc3	Lodgepole pine–Juniper–Dwarf huckleberry	02	LJ	31	2	-29	-94	6	-25	-82
SBSmc3	Lodgepole pine–Feathermoss–Cladina	03	LF	615	249	-366	-60	427	-188	-31
SBSmc3	Hybrid white spruce–Huckleberry–Soopolallie	04	SS	57	8	-50	-87	21	-36	-63
SBSmc3	Hybrid white spruce–Twinberry	07	ST	115	66	-49	-43	96	-19	-16
Total SBSmc3				**818**	**324**	**-493**	**-282**	**550**	**-268**	**-33**
ESSFmv1	Subalpine fir–Huckleberry–Gooseberry	04	FG	538	273	-265	-49	374	-163	-30
ESSFmv1	Sitka valerian–Globeflower moist meadow	00	VG	<1	<1	0	0	<1	0	0
Total Upland				**538**	**273**	**-265**	**-49**	**374**	**-163**	**-30**
ESSFmv1	Rock	00	RO	<1	<1	0	0	<1	0	0
ESSFmv1	Talus	00	TA	2	2	0	0	2	0	0
Total Non-vegetated, Sparsely Vegetated, Anthropogenic				**2**	**2**	**0**	**0**	**2**	**0**	**0**
Total ESSFmv1				**539**	**274**	**-265**	**-49**	**376**	**-163**	**-30**
ESSFmvp1	Subalpine fir–Indian hellebore	00	FH	36	33	-3	-8	35	-2	-5
ESSFmvp1	Kinnikinnick–Cladonia	00	KC	1	1	0	0	1	0	0
ESSFmvp1	Sitka valerian–,Globeflower moist meadow	00	VG	19	15	-4	-21	16	-3	-15
Total Upland				**57**	**50**	**-7**	**-12**	**52**	**-5**	**-8**
ESSFmvp1	Moraine	00	MN	<1	<1	0	0	<1	0	0
ESSFmvp1	Talus	00	TA	1	1	0	0	1	0	0
Total Non-vegetated, Sparsely Vegetated, Anthropogenic				**1**	**1**	**0**	**0**	**1**	**0**	**0**
Total ESSFmvp1				**58**	**51**	**-7**	**-29**	**53**	**-5**	**-8**
Total Potential Plant Species-at-risk Habitat				**1,415**	**650**	**-765**	**-54**	**979**	**-435**	**-31**

Note: BGC = Biogeoclimatic, ESSFmv1 = Nechako Very Cold Engelmann Spruce Subalpine Fir variant; ESSFmv1p = Nechako Very Cold Engelmann Spruce-Subalpine Fir Parkland variant. SBSmc3 = Kluskus Moist Cold Sub-Boreal Spruce variant.
Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values

Table 5.4.6-7: Potential Species-at-Risk Habitat: Linear Component Effects on Ecosystem Loss in the LSA

BGC Unit	Site Series Name	Site Series	Map Code	Baseline Case (ha)	Project Case			Post-Closure Case		
					Remaining (ha)	Area Change (ha)	Percent Change (%)	Remaining and Reclaimed (ha)	Area Change (ha)	Percent Change (%)
SBSdk	Drummond's willow–Bluejoint	00*	Fl05	1	1	0	0	1	0	0
SBSdk	Exposed Soils	00	ES	2	2	0	0	2	0	0
SBSdk	Saskatoon–Slender wheatgrass	81*	SW	1	1	0	0	1	0	0
SBSdk	Lodgepole pine–Juniper–Ricegrass	02*	LJ	25	22	-3	-10	22	-3	-10
SBSdk	Lodgepole pine–Feathermoss–Cladina	03	LC	182	164	-18	-10	182	0	0
SBSdk	Douglas fir–Soopolallie–Feathermoss	04*	DS	5	5	<1	-4	5	<1	-4
SBSdk	Hybrid white spruce–Twinberry–Coltsfoot	06	ST	501	446	-55	-11	501	0	0
SBSdk	Black cottonwood–Dogwood–Prickly rose	08	CD	4	4	<1	-7	4	0	0
Total SBSdk				**720**	**644**	**-76**	**-10**	**720**	**-3**	**<-1**
SBSdw3	Drummond's willow–Bluejoint	00*	Fl05	2	2	<1	-10	2	<1	-10
SBSdw3	Saskatoon–Slender wheatgrass	81*	SW	3	3	<1	-10	3	<1	-10
SBSdw3	Douglas fir–Lodgepole pine–Cladonia	02*	DC	12	11	-1	-11	11	-1	-11
SBSdw3	Lodgepole pine–Feathermoss–Cladina	03	LC	47	43	-4	-8	47	0	0
SBSdw3	Hybrid white spruce–Ricegrass	04	SR	75	67	-9	-11	75	0	0
Total SBSdw3				**139**	**125**	**-14**	**-10**	**139**	**-1**	**<-1**
SBSmc2	Lodgepole pine–Huckleberry–Cladonia	02	PH	54	53	-1	-2	53	<-1	-1
SBSmc2	Hybrid white spruce–Huckleberry–Dwarf blueberry	04	HB	29	26	-3	-9	29	0	0
SBSmc2	Hybrid white spruce–Twinberry–Coltsfoot	05	TC	8	8	-1	-9	8	0	0
SBSmc2	Hybrid white spruce–Horsetail	10	SH	3	3	0	0	3	0	0
Total SBSmc2				**94**	**90**	**-4**	**-5**	**94**	**<-1**	**<-1**
SBSmc3	Lodgepole pine–Juniper–Dwarf huckleberry	02	LJ	13	12	-1	-10	13	0	0
SBSmc3	Lodgepole pine–Feathermoss–Cladina	03	LF	259	234	-25	-10	256	-3	-1
SBSmc3	Hybrid white spruce–Huckleberry–Soopolallie	04	SS	109	104	-5	-5	109	0	0
SBSmc3	Hybrid white spruce–Twinberry	07	ST	440	410	-30	-7	439	-1	<1

BGC Unit	Site Series Name	Site Series	Map Code	Baseline Case (ha)	Project Case			Post-Closure Case		
					Remaining (ha)	Area Change (ha)	Percent Change (%)	Remaining and Reclaimed (ha)	Area Change (ha)	Percent Change (%)
Total SBSmc3				**821**	**760**	**-61**	**-7**	**817**	**-4**	**-1**
ESSFmv1	Subalpine fir–Huckleberry–Gooseberry	04	FG	21	20	-1	-3	21	0	0
Total ESSFmv1				**21**	**20**	**-1**	**-3**	**21**	**0**	**0**
Total Potential Plant Species-at-risk Habitat				**1,796**	**1,639**	**-155**	**-9**	**1,791**	**-8**	**<-1**

Note: BGC = Biogeoclimatic, SBSdk = Dry Cool Sub-Boreal Spruce, SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant, SBSmc2 = Babine Moist Cold Sub-Boreal Spruce variant; SBSmc3 = Kluskus Moist Cold Sub-Boreal Spruce variant; ESSFmv1 = Nechako Very Cold Engelmann Spruce Subalpine Fir variant
Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values
*Ecosystems at Risk, see **Section 5.4.6.1.7.3**

5.4.6.3.8.1.3 Combined Project Components

Combined Project components include the mine site, mine site access road, freshwater supply pipeline, airstrip, transmission line, and Kluskus FSR. A total of 3,210 ha of potential species-at-risk habitat occurs within the LSA for combined Project components (**Table 5.4.6-8**). During the Project Case 920 ha (29%) will be impacted by Project activities. Following reclamation in the Post-closure Case there will be a loss of 439 ha (14%), due to Project activities such as clearing and site disturbance.

Table 5.4.6-8: Potential Species-At-Risk Habitat: Combined Components Effects on Ecosystem Loss in the LSA

BGC Unit	Baseline Case (ha)	Project Case			Post-Closure Case		
		Remaining (ha)	Area Change (ha)	Percent Change (%)	Remaining and Reclaimed (ha)	Area Change (ha)	Percent Change (%)
SBSdk	720	644	-76	-10	720	0	0
SBSdw3	139	125	-14	-10	139	0	0
SBSmc2	94	90	-4	-5	94	0	0
SBSmc3	1,639	1,084	-555	-34	1,367	-272	-17
ESSFmv1	560	295	-265	-47	397	-163	-29
ESSFmvp1	58	51	-7	-12	53	-5	-8
Total Potential Species-at-risk Habitat	**3,210**	**2,289**	**-920**	**-29**	**2,770**	**-439**	**-14**

Note: BGC = Biogeoclimatic, SBSdk = Dry Cool Sub-Boreal Spruce, SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant, SBSmc2 = Babine Moist Cold Sub-Boreal Spruce variant; SBSmc3 = Kluskus Moist Cold Sub-Boreal Spruce variant; ESSFmv1 = Nechako Very Cold Engelmann Spruce Subalpine Fir variant; ESSFmv1p = Nechako Very Cold Engelmann Spruce-Subalpine Fir Parkland variant.; Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values; Mine-related landforms are generated by the Project and do not occur at baseline

5.4.6.3.8.2 Dust Deposition

5.4.6.3.8.2.1 Mine Site

During the Project Case, 205 ha (14%) of potential plant species-at-risk habitat will be impacted by dust (**Table 5.4.6-9**). The dust buffer was set at 125 m surrounding the mine footprint. The majority of this impact will occur in the SBSmc3, Lodgepole pine–Feathermoss–Cladina (03/LF) and ESSFmv1, Subalpine fir–Huckleberry–Gooseberry (04/FG) ecosystems, with 93 ha (15%) and 81 ha (15%) affected, respectively.

Table 5.4.6-9: Potential Species-at-Risk Habitat: Mine Site Effects of Dust Deposition in the LSA

BGC Unit	Site Series Name	Site Series	Map Code	Baseline Case (ha)	Project Case	
					Dust Zone (ha)	Percent of Baseline (%)
SBSmc3	Lodgepole pine–Juniper–Dwarf huckleberry	02	LJ	31	2	6
SBSmc3	Lodgepole pine–Feathermoss–Cladina	03	LF	615	93	15
SBSmc3	Hybrid white spruce–Huckleberry–Soopolallie	04	SS	57	5	8
SBSmc3	Hybrid white spruce–Twinberry	07	ST	115	17	15
Total SBSmc3				**818**	**116**	**14**
ESSFmv1	Subalpine fir–Huckleberry–Gooseberry	04	FG	538	81	15
ESSFmv1	Sitka valerian–Globeflower moist meadow	00	VG	0	0	0
Total Upland				**538**	**81**	**15**
ESSFmv1	Rock	00	RO	<1	0	0
ESSFmv1	Talus	00	TA	2	< 1	1
Total Non-Vegetated, Sparsely Vegetated, and Anthropogenic				**2**	**0**	**0**
Total ESSFmv1				**540**	**81**	**15**
ESSFmvp1	Subalpine fir–Indian Hellebore	00	FH	36	3	9
ESSFmvp1	Kinnikinnick–Cladonia	00	KC	1	0	0
ESSFmvp1	Sitka valerian–globeflower moist meadow	00	VG	19	3	18
Total Upland				**57**	**7**	**12**
ESSFmv1	Moraine	00	MN	<1	<1	<1
ESSFmvp1	Talus	00	TA	1	1	100
Total Non-Vegetated, Sparsely Vegetated, and Anthropogenic				**1**	**1**	**100**
Total ESSFmvp1				**58**	**7**	**11**
Total ESSF				**597**	**87**	**15**
Total Upland				**1,412**	**204**	**14**
Total Non-Vegetated, Sparsely Vegetated, and Anthropogenic				**3**	**1**	**45**
Total Potential Species-at-Risk Habitat				**1,415**	**205**	**14**

Note: BGC = Biogeoclimatic, SBSmc3 = Kluskus Moist Cold Sub-Boreal Spruce variant; ESSFmv1 = Nechako Very Cold Engelmann Spruce Subalpine Fir variant; ESSFmv1p = Nechako Very Cold Engelmann Spruce-Subalpine Fir Parkland variant
Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values; Mine-related landforms are generated by the Project and do not occur at baseline

5.4.6.3.8.2.2 Linear Components

During the Project Case 605 ha (34%) of potential species-at-risk habitat along linear project components will be impacted by dust deposition (**Table 5.4.6-10**). Over half of the dust effects are predicted to occur within two ecosystems—the SBSdk, Hybrid white spruce–Twinberry–Coltsfoot (06/ST) (157 ha, 31%), and the SBSmc3, Hybrid white spruce–Twinberry (07/ST) (153 ha, 35%).

Table 5.4.6-10: Potential Species-at-Risk Habitat: Linear Component Effects of Dust Deposition in the LSA

BGC Unit	Site Series Name	Site Series	Map Code	Baseline LSA (ha)	Dust Zone (ha)	Percent of Baseline (ha)
SBSdk	Drummond's willow–Bluejoint	00	Fl05	1	0	0
SBSdk	Exposed Soils	00	ES	2	1	25
SBSdk	Lodgepole pine–Juniper–Ricegrass	02	LJ	25	7	28
SBSdk	Lodgepole pine–Feathermoss–Cladina	03	LC	182	63	34
SBSdk	Douglas fir–Soopolallie–Feathermoss	04	DS	5	2	38
SBSdk	Hybrid white spruce–Twinberry–Coltsfoot	06	ST	501	157	31
SBSdk	Black cottonwood–Dogwood–Prickly rose	08	CD	4	1	29
Total SBS dk				**719**	**230**	**32**
SBSdw3	Drummond's willow–Bluejoint	00	Fl05	2	1	40
SBSdw3	Douglas fir–Lodgepole pine–Cladonia	02	DC	12	4	35
SBSdw3	Lodgepole pine–Feathermoss–Cladina	03	LC	47	14	30
SBSdw3	Hybrid white spruce–Ricegrass	04	SR	75	24	32
SBSdw3	Saskatoon–Slender wheatgrass	81	SW	3	1	26
Total SBSdw3				**139**	**44**	**32**
SBSmc2	Lodgepole pine–Huckleberry–Cladonia	02	PH	54	21	40
SBSmc2	Hybrid white spruce–Huckleberry–Dwarf blueberry	04	HB	29	9	31
SBSmc2	Hybrid white spruce–Twinberry–Coltsfoot	05	TC	9	3	38
SBSmc2	Hybrid white spruce–Horsetail	10	SH	3	1	23
Total SBSmc2				**94**	**34**	**36**
SBSmc3	Lodgepole pine–Juniper–Dwarf huckleberry	02	LJ	13	5	37
SBSmc3	Lodgepole pine–Feathermoss–Cladina	03	LF	259	89	34
SBSmc3	Hybrid white spruce–Huckleberry–Soopolallie	04	SS	109	43	39
SBSmc3	Hybrid white spruce–Twinberry	07	ST	440	153	35
Total SBSmc3				**821**	**289**	**35**
ESSFmv1	Subalpine fir–Huckleberry–Gooseberry	04	FG	21	7	32
Total ESSFmv1				**21**	**7**	**32**
Total Potential Species At Risk Habitat				**1,795**	**605**	**34**

Note: BGC = Biogeoclimatic, SBSdk = Dry Cool Sub-Boreal Spruce, SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant, SBSmc2 = Babine Moist Cold Sub-Boreal Spruce variant; SBSmc3 = Kluskus Moist Cold Sub-Boreal Spruce variant; ESSFmv1 = Nechako Very Cold Engelmann Spruce Subalpine Fir variant
Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values; Mine-related landforms are generated by the Project and do not occur at baseline

5.4.6.3.8.3 Spread of Invasive Plants

Invasive plants were recorded at lower elevations along the roads and transmission line corridor. Vegetation clearing and soil disturbance during construction may result in the introduction and ultimately the spread of invasive plants. Combined with a possible increase in soil N, the proliferation of invasive plants is a potential environmental effect. The IAPP (BC MOFR, 2013), identified a total of 232 records and 24 invasive plants along the transmission line and Kluskus FSR.

5.4.6.3.8.4 Nitrogen Deposition

A total of 52 ha of potential plant species-at-risk habitat overlaps where N deposition is predicted to exceed the 5 $kg/ha^{-1}/yr^{-1}$ threshold. The area of high N deposition is shown on **Figure 5.4.6-1**.

5.4.6.3.8.5 Mitigation

Impacts to potential plant species-at-risk habitat will be mitigated by minimizing the Project footprint, and by implementing management plans to reduce dust deposition, nitrogen deposition, and invasive species proliferation; post closure, disturbed areas will also be reclaimed. A brief summary of mitigation measures applicable to reducing Project effects is provided below. Other EA report sections and management plans provide specific details: AQEMP (**Section 12.2.1.18.4.9**), Transportation and Access Management Plan (TAMP) (**Section 12.2.1.18.4.14**), Atmospheric and Acoustic Environment Effects Assessment Section (**Section 5.2**), ISMP (**Section 12.2.1.18.4.5**), Landscape, Soils, and Vegetation Management and Restoration plan (**Section 12.2.1.18.4.4**), Sediment and Erosion Control Plan (SECP) (**Section 12.2.1.18.4.1**), and the RCP (**Section 2.6**).

5.4.6.3.8.5.1 Minimize Disturbance

- Minimize the extent of grubbing, stripping, and the removal of shrubs and herbaceous species within the mine site area, and along Project-related linear features; and
- In areas requiring clearing only (e.g., the transmission line), retain the humus layer and vegetation root mat whenever and wherever possible.

5.4.6.3.8.5.2 Implement Dust Emissions Management

Most dust emissions occur from vehicle travel on non-paved roads (e.g., mine haul roads), and from materials handling (bulldozers, graders, truck dumping) (refer to Air Quality, **Section 5.2.4**). Dust effects will be mitigated using a combination of administrative, design, and emission control strategies:

- Administrative: road dust emissions are directly related to vehicle speed, which will be controlled throughout the mine site;
- Design: road dust emissions are directly related to road silt content, and haul road surfaces will be constructed of coarse aggregate with very low silt content;

- Control: unpaved road surfaces will be wetted as needed to control dust emissions when conditions are not wet or frozen, and the wetting agent may include a chemical to extend and improve dust control over using water alone. The specific chemical has not yet been selected, and it is anticipated that a number of chemicals will be tried to ensure optimum performance. This is common practice at mine sites, and chemical selection will be informed by experiences at other mines in similar climate. Wetting with dust suppressant chemical addition is anticipated to reduce road dust emission by 90%; and
- Control: materials handling (dumping, bulldozing, grading) generates PM emissions, and wetting of the material before handling dramatically reduces PM emissions. Much of the material coming from the pit is saturated as it is excavated from below the water table and a 50% reduction in material handling PM emissions is anticipated due to material wetting prior to handling.

5.4.6.3.8.5.3 Mitigate Against Invasive Plants

- EDRR is imperative to invasive species management;
- Minimize all soil disturbances (roads and machinery activity);
- Reclaim and re-establish vegetation on disturbed areas as soon as possible;
- Used weed-free seed for reclamation, and weed-free hay bales for erosion control;
- Clean equipment and materials prior to entering the Project area;
- Monitor for invasive species to detect occurrences, and implement control measures as appropriate;
- Implement ISMP (**Section 12.2.1.18.4.5**); and
- Monitor and apply control measures as described in the ISMP.

5.4.6.3.8.5.4 Nitrogen Deposition

- Implement emissions measures as described in the Air Quality and Emissions Management Plan including:
  - Reducing vehicle emissions by setting speed limits, fuel selection, use of vehicles that meet emission standards, and vehicle and equipment maintenance;
  - Ensuring the incinerator and other sources of emissions meet all relevant Canadian emission requirements; and
  - Meeting requirements of Industry Codes and Best Practices for design.

5.4.6.3.8.5.5 Reclamation and Closure Plan

An RCP (**Section 2.6**) will provide methods for decommissioning and closure activities of mining developments. The RCP outlines all the mine features requiring reclamation, recommendations for site and soil preparation, and revegetation intended for all the mine facilities including:

- Incorporation of mine-related landforms into the landscape and re-establishment of natural landforms to become baseline ecosystems in the remaining sites;
- Mine-related landforms (i.e., open pit, tailing storage facilities (TSF), waste rock dumps) will be reclaimed into rocky slopes, slopes with upland beach, wetlands, and permanent ponds;
- Natural landforms will have characteristics and relief similar to pre-mining conditions and following reclamation and sufficient time are expected to return to conditions similar to baseline;
- Where feasible decommission and reclaim any roads;
- Salvage topsoil and store for use during the closure phase; and
- Re-plant with native species with value for wildlife, traditional use, and species at risk, specifically whitebark pine for reclamation.

5.4.6.3.8.5.6 Reclamation Research

A reclamation research program will be initiated during year three, or as soon as a suitable site to conduct the research is available (refer to Opportunities for Reclamation Research **Section 2.6**).

5.4.6.3.8.5.7 Effectiveness of Mitigation

Table 5.4.6-11 provides ratings for effectiveness of mitigation measures to avoid or reduce potential effects on potential plant species at risk habitat during mine site development. Mitigation measures will be based on site-specific information and construction engineering and are therefore preliminary at this stage.

Table 5.4.6-11: Mitigation Measures and Effectiveness of Mitigation to Avoid or Reduce Potential Effects on Potential Plant Species-at-Risk Habitat during Mine Site Development

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
Ecosystem loss	Construction, Operations, Closure, Post-closure	Minimize the extent of grubbing, stripping, and the removal of shrubs and herbaceous species within the mine site area, and along Project-related linear features	Moderate
		In areas requiring clearing only (e.g., the transmission line), retain the humus layer and vegetation root mat whenever and wherever possible	Moderate
	Closure	Incorporation of mine-related landforms into the landscape and re-establishment of natural landforms to become baseline ecosystems in the remaining sites	Moderate
		Mine-related landforms (i.e., open pit, TSF, waste rock dumps) will be reclaimed into rocky slopes, slopes with upland beach, wetlands, and permanent ponds	Low
		Natural landforms will have characteristics and relief similar to pre-mining conditions and following reclamation and sufficient time are expected to return to conditions similar to baseline	Moderate
		Where feasible decommission and reclaim any roads	Moderate
		Salvage topsoil and store for use during the closure phase	Moderate
		Re-plant with native species with value for wildlife, traditional use, and species at risk, specifically whitebark pine for reclamation	Moderate
Dust deposition	Construction, Operations, Closure, Post-closure	Vehicle speed will be controlled throughout the mine site as described in the TAMP (**Section 12.2.1.18.4.14**)	High
		Haul road surfaces will be constructed of coarse aggregate with very low silt content	High
		Unpaved road surfaces will be wetted as needed to control dust emissions when conditions are not wet or frozen, and the wetting agent may include a chemical to extend and improve dust control over using water alone	High
		Materials will be wetted prior to handling	High
Spread of invasive plants	Construction, Operations, Closure, Post-closure	EDRR is imperative to invasive species management	Moderate
		Minimize all soil disturbances (roads and machinery activity)	Moderate

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
		Reclaim and re-establish vegetation on disturbed areas as soon as possible	Moderate
		Used weed-free seed for reclamation, and weed-free hay bales for erosion control	Moderate
		Clean equipment and materials prior to entering the Project area	Moderate
		Monitor for invasive species to detect occurrences, and implement control measures as appropriate	Moderate
		Implement ISMP (**Section 12.2.1.18.4.5**)	Moderate
		Monitor and apply control measures as described in the ISMP	Moderate
Nitrogen deposition	Construction, Operations, Closure, Post-closure	Reducing vehicle emissions by setting speed limits, fuel selection, use of vehicles that meet emission standards, and vehicle and equipment maintenance	Moderate
		Ensuring the incinerator and other sources of emissions meet all relevant Canadian emission requirements	Moderate
		Meeting requirements of Industry Codes and Best Practices for design	Moderate

Note: EDRR = early detection and rapid response; ISMP = Invasive Species Management Plan; TAMP = Transportation and Access Management Plan; TSF = Tailings Storage Facility

The mitigation success ratings shown in **Table 5.4.6-11** are incorporated into the confidence ratings defined in **Section 4.3.5** and summarized in **Table 5.4.6-16** and **Table 5.4.6-17**. In summary, low success rating means mitigation has not been proven successful, moderate success rating means mitigation has been proven successful elsewhere, and high success rating means mitigation has been proven effective.

The mitigation success of ecosystem loss on potential plant species at risk habitat is rated moderate overall because reclamation success has been proven successful elsewhere; however, the uncertainty lies is restoring areas to baseline condition. The mitigation success of dust deposition is rated high because mitigation measures such as dust suppression techniques have proven successful. The mitigation success of nitrogen deposition is rated moderate because mitigation measures described in the AQEMP (**Section 12.2.1.18.4.9**) will reduce the overall amount of N deposition. However the effect is considered long term, as it is uncertain how long excess nitrogen will persist in affected areas. The mitigation success of spreading invasive plants is rated moderate overall because mitigation measures follow BMPs identified by the Invasive Species Council of BC and the ISMP.

5.4.6.3.9 Indicator 3: Ecosystems at Risk

Baseline ecosystem mapping prepared for the baseline report (**Appendix 5.1.3.3A**, Annex 3) formed the basis of the assessment of effects for the ecosystems at risk indicator.

5.4.6.3.9.1 Ecosystem Loss

A total of two Red- and eight Blue-listed ecosystems at risk will be potentially affected by the proposed Project activity. A total of 8 ha (9 %) will be lost during the Project Case in the LSA, all occurring along the proposed transmission line, and adjacent to the existing Kluskus FSR (**Table 5.4.6-12**). The two ecosystems losing the most will be SBSdk Lodgepole pine–Juniper–Ricegrass (02/LJ) (3 ha, 11 %) and SBSdw3 Lodgepole pine–Black spruce–Feathermoss (05/BF) (2 ha, 9%). Some ecosystems at risk at baseline are small in size but the percent loss is higher. The SBSdk Douglas fir-Soopolalie-Feathermoss (04/DS) has a change of 17% (<1 ha) from Baseline Case, and the SBSdw3 Douglas fir-Lodgepole pine-Cladonia (02/DC) and the Hybrid white spruce-Pink Spirea-Prickly rose (06/SS) show a potential change of 12% (1 ha).

Transmission line disturbances will be limited mostly to cutting of vegetation and light soil disturbance, and closure efforts will include reclamation to native vegetation. Vegetation loss from transmission pole installation, access-road construction, and vegetation clearing for the right-of-way (ROW) totals <1% of the LSA (approximately 14,300 ha).

Table 5.4.6-12: Ecosystems-At-Risk: Linear Component Effects on Ecosystem Loss in the LSA

BGC Unit	Site Series Name	Site Series	Map Code	BC List	Baseline Case (ha)	Remaining (ha)	Area Change (ha)	Percent Change (%)	Remaining (ha)	Area Change (ha)	Percent Change (%)
SBSdk	Saskatoon–Slender wheatgrass	81	SW	Red	1	1	0	0	1	0	0
SBSdk	Lodgepole pine–Juniper–Ricegrass	02	LJ	Blue	24	21	-3	-11	21	-3	-11
SBSdk	Douglas fir–Soopolallie–Feathermoss	04	DS	Blue	1	1	<-1	-17	1	<-1	-17
SBSdk	Black cottonwood–Dogwood–Prickly rose	08	CD	Blue	3	3	0	-10	3	0	-10
SBSdk	Drummond's willow–Bluejoint	00	Fl05	Blue	1	1	<-1	-3	1	<-1	-3
Total SBSdk					**29**	**26**	**-3**	**-11**	**29**	**-3**	**-11**
SBSdw3	Saskatoon–Slender wheatgrass	81	SW	Red	3	3	<-1	-10	3	<-1	-10
SBSdw3	Douglas fir–Lodgepole pine–Cladonia	02	DC	Blue	11	9	-1	-12	9	-1	-12
SBSdw3	Lodgepole pine–Black spruce–Feathermoss	05	BF	Blue	22	20	-2	-9	20	-2	-9
SBSdw3	Hybrid white spruce–Pink Spirea–Prickly rose	06	SS	Blue	10	8	-1	-12	8	-1	-12

BGC Unit	Site Series Name	Site Series	Map Code	BC List	Baseline Case (ha)	Remaining (ha)	Area Change (ha)	Percent Change (%)	Remaining (ha)	Area Change (ha)	Percent Change (%)
SBSdw3	Drummond's willow–Bluejoint	00	Fl05	Blue	2	2	<-1	-10	2	<-1	-10
Total SBSdw3					**48**	**43**	**-5**	**-9**	**48**	**-5**	**-9**
Total Ecosystems At Risk					**77**	**69**	**-8**	**-9**	**77**	**-8**	**-9**

Note: BGC = Biogeoclimatic, SBSdk = Dry Cool Sub-Boreal Spruce, SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant, Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values

5.4.6.3.9.2 Dust Deposition

Dust deposition will impact a total of 32 ha (32 %) of ecosystems at risk during the Project Case (**Table 5.4.6-13**). The ecosystems at risk with the most area affected are SBSdw3, Lodgepole pine–Black spruce–Feathermoss (05/BF) (13 ha, 34%) and SBSdk, Lodgepole pine–Juniper–Ricegrass (02/LJ) (7 ha, 28%). At Post-closure, sources of dust will be minimal and not expected to impact ecosystems at risk.

Table 5.4.6-13: Ecosystems-At Risk: Linear Component Effects of Dust in the LSA

BGC Unit	Site Series Name	Site Series	Map Code	BC List	Baseline Case (ha)	Project Case: Dust Zone (ha)	Project Case: Percent of Baseline (%)
SBSdk	Drummond's willow–Bluejoint	00	Fl05	Blue	1	<1	<1
SBSdk	Lodgepole pine–Juniper–Ricegrass	02	LJ	Blue	25	7	28
SBSdk	Douglas fir–Soopolallie–Feathermoss	04	DS	Blue	5	2	38
SBSdk	Black cottonwood–Dogwood–Prickly rose	08	CD	Blue	4	1	29
Total SBSdk					**34**	**10**	**29**
SBSdw3	Saskatoon–Slender wheatgrass	81	SW	Red	3	1	26
SBSdw3	Douglas fir–Lodgepole pine–Cladonia	02	DC	Blue	12	4	35
SBSdw3	Lodgepole pine–Black spruce–Feathermoss	05	BF	Blue	38	13	34
SBSdw3	Hybrid white spruce–Pink spirea–Prickly rose	06	SS	Blue	11	3	31
SBSdw3	Drummond's willow–Bluejoint	00	Fl05	Blue	2	1	40
Total SBSdw3					**66**	**22**	**33**
Total Ecosystems At Risk					**100**	**32**	**32**

Note: BGC = Biogeoclimatic; SBSdk = Dry Cool Sub-Boreal Spruce; SBSdw3 = Stuart Dry Warm Sub-Boreal Spruce variant; Numbers are rounded for presentation purposes, and as a result it may appear that the totals do not equal the sum of the individual values

5.4.6.3.9.3 Spread of Invasive Plants

Ecosystems at risk do not overlap with known records of invasive plants but do occur in close proximity, within 50 m. The IAPP (BC MOFR, 2013) identified a total of 232 records and 24 invasive plants along the transmission line and Kluskus FSR; these are potential source and may result in spreading invasive plants to newly disturbed areas during construction and operation. Vegetation clearing and soil disturbance during construction may result in the introduction and ultimately the spread of invasive plants.

5.4.6.3.9.4 Nitrogen Deposition

Ecosystems at risk within the Project footprint all occur along the transmission line. Other than during the construction phase for the transmissions line, which will be relatively brief, vehicular traffic levels (the primary source of N) will be low, and NO_x levels are not predicted to exceed ambient air quality standards. Therefore, no effect of N deposition on ecosystems at risk is expected.

5.4.6.3.9.5 Mitigation

Impacts to ecosystems at risk will be mitigated by minimizing the Project footprint and by implementing management plans to reduce dust deposition, gaseous contaminants, and invasive species proliferation, and reclaiming impacted areas post-closure.

5.4.6.3.9.5.1 Minimize Disturbance

- Minimize the extent of grubbing, stripping, and the removal of shrubs and herbaceous species within the mine site area and along Project related linear features; and
- In areas requiring clearing only (e.g., the transmission line), retain the humus layer and vegetation root mat whenever and wherever possible.

5.4.6.3.9.5.2 Implement Dust Emissions Management

In addition to the dust management measures provided in management plans, ecosystems at risk should be highlighted for protection from road dust. Most dust emissions occur from vehicle travel on unpaved road (e.g., mine haul roads), and from materials handling (bulldozers, graders, truck dumping) (refer to Air Quality Effects Assessment, **Section 5.1.1.2**). One of the mitigation measures for dust deposition effects is to wet unpaved road surfaces as necessary when conditions are not wet or frozen. The wetting agent will include a chemical to extend and improve dust control over using water alone.

5.4.6.3.9.5.3 Mitigate Against Invasive Plants

- EDRR is imperative to invasive species management;
- Implement ISMP (**Section 12.2.1.18.4.5**); and
- Monitor and apply control measures as described in the ISMP.

5.4.6.3.9.5.4 Effectiveness of Mitigation

Table 5.4.6-14 provides ratings for effectiveness of mitigation measures to avoid or reduce potential effects on ecosystems at risk during mine site development. Mitigation measures will be based on site-specific information and construction engineering and are therefore preliminary at this stage.

Table 5.4.6-14: Mitigation Measures and Effectiveness of Mitigation to Avoid or Reduce Potential Effects on Ecosystems at Risk during Mine Site Development

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
Ecosystem loss	Construction, Operations, Closure, Post-closure	Minimize the extent of grubbing, stripping, and the removal of shrubs and herbaceous species within the mine site area and along Project related linear features	Moderate
		In areas requiring clearing only (e.g., the transmission line), retain the humus layer and vegetation root mat whenever and wherever possible	Moderate
Dust deposition	Construction, Operations, Closure, Post-closure	Vehicle speed will be controlled throughout the mine site as described in the TAMP (**Section 12.2.1.18.4.14**)	High
		Haul road surfaces will be constructed of coarse aggregate with very low silt content	High
		Unpaved road surfaces will be wetted as needed to control dust emissions when conditions are not wet or frozen, and the wetting agent may include a chemical to extend and improve dust control over using water alone	High
		Materials will be wetted prior to handling	High
Spread of invasive plants	Construction, Operations, Closure, Post-closure	EDRR is imperative to invasive species management	Moderate
		Implement ISMP (**Section 12.2.1.18.4.5**)	Moderate
		Monitor and apply control measures as described in the ISMP	Moderate

Note: EDRR = early detection and rapid response; ISMP = Invasive Species Management Plan; TAMP = Transportation and Access Management Plan

The mitigation success ratings shown in **Table 5.4.6-14** are incorporated into the confidence ratings defined in **Section 4.3.5** and summarized in **Table 5.4.6-16** and **Table 5.4.6-17**. In summary, low success rating means mitigation has not been proven successful, moderate success rating means mitigation has been proven successful elsewhere, and high success rating means mitigation has been proven effective.

The mitigation success of ecosystem loss on ecosystems at risk is rated moderate overall because where ecosystems at risk occur along the transmission line, ground disturbance will be minimal and thus will increase the likelihood of successful restoration to baseline ecosystems. The potential overall loss of ecosystems at risk within the transmission line ROW is less than 1% (and potentially nil) if ecosystems at risk are avoided by micro-rerouting of the transmission line. The mitigation success of dust deposition is rated high because mitigation measures such as dust suppression techniques have proven successful. The mitigation success of spreading invasive plants is rated moderate overall because mitigation measures follow BMPs identified by the Invasive Species Council of BC and the ISMP.

5.4.6.4 Residual Effects and their Significance

A residual effect is an environmental effect that remains, or is predicted to remain, even after mitigation measures have been applied (**Section 4.3.5**). **Table 5.4.6-15** summarizes the potential effects of the Project on the Plant Species and Ecosystems at Risk VC, and identifies which effects will be carried forward in the assessment, namely ecosystem loss and nitrogen deposition. The complete restoration of baseline conditions following project closure is not possible, and therefore the overall residual effect on plant species and ecosystems at risk loss is summarized as adverse (**Table 5.4.6-15**). Project effects on whitebark pine are also adverse for dust and N deposition, and for whitebark pine regeneration.

Table 5.4.6-15: Summary of Potential Project Effects to be Carried Forward into the Assessment of Plant Species and Ecosystems at Risk

Project Effects	VC Indicator	Project Phase				Potential for Residual Effects after Mitigation	Carried Forward
		Construction	*Operations*	*Closure*	*Post-closure*		
Ecosystem loss	Whitebark pine	√	√	√	√	Yes	Yes
	Potential plant species-at-risk habitat	√	√	√	√	Yes	Yes
	Ecosystems at risk	√	√	√	√	Yes	Yes
Dust deposition	Whitebark pine	√	√	X	X	No	No
	Potential plant species-at-risk habitat	√	√	X	X	No	No
	Ecosystems at risk	√	√	X	X	No	No
Spread of Invasive Plants	Whitebark pine	X	X	X	X	No	No
	Potential plant species-at-risk habitat	√	√	X	X	No	No
	Ecosystems at risk	X	X	X	X	No	No
Nitrogen deposition	Whitebark pine	√	√	√	√	Yes	Yes
	Potential plant species-at-risk habitat	√	√	√	√	Yes	Yes
	Ecosystems at risk	X	X	X	X	No	No
Whitebark pine regeneration	Whitebark pine	√	√	√	√	Yes	Yes

Note: √ = Potential Project effect likely, X = potential Project effect unlikely

5.4.6.4.1 Significance of Potential Residual Effects

5.4.6.4.1.1 Ecosystem Loss

Assessment of the potential residual effect significance of ecosystem loss on is presented in **Table 5.4.6-16**. The three indicators (whitebark pine, potential plant species at risk and ecosystems at risk) were considered when assessing residual effects.

By post-closure, buildings and infrastructure will have been removed and reclamation measures initiated. The ecological context remains high because the Project will affect a SARA-listed species. The magnitude is medium because there is an 11% reduction of the original population of whitebark pine and a 14% reduction in potential plant species at risk habitat. The overall loss of ecosystems at risk within the transmission line ROW is less than 1% of baseline. Reclamation measures for whitebark pine loss will emphasize rust screening, mycorrhizal inoculation, transplanting rust-resistant whitebark pine trees, and monitoring to ensure survival; therefore, the effects are considered reversible. Potential plant species-at-risk habitat occurring on mine-related landforms will differ substantially from baseline condition (i.e., open pit, tailings storage facility, and waste rock piles) and will be considered a permanent and irreversible loss. The potential overall loss of ecosystems at risk within the transmission line ROW is less than 1% and possibly none if ecosystems at risk are avoided by micro-rerouting of the transmission line.

Geographic extent is local, as effects are limited to the LSA. The duration is chronic, as it is uncertain how long it will take to restore whitebark pine populations, but most definitely greater than 35 years until whitebark pine trees become cone producing. The frequency of loss will be once because construction clearing occurs on one occasion. The likelihood determination and level of certainty are ranked as moderate. Overall the effect is ranked as Not Significant—moderate with a moderate level of confidence for significance given the unknown related to transplanting whitebark pine trees and reclaiming the portion of the population lost.

Table 5.4.6-16: Potential Residual Effects Significance of Ecosystem Loss on Plant Species and Ecosystems at Risk VC

Effect Attribute	Post-Closure
Context	high
Magnitude	medium
Geographic extent	local
Duration	chronic
Reversibility	mine-related landforms – no natural landforms -yes
Frequency	once
Likelihood Determination	moderate
Level of confidence for likelihood	moderate
Significance determination	Not Significant (moderate)
Level of confidence for significance	moderate

5.4.6.4.1.2 Nitrogen Deposition

Nitrogen deposition will primarily come from mine fleet emissions, and as such, mitigation measures may not be sufficient to reduce the level of N deposition below the value of 5 kg $N/ha^{-1}/y^{-1}$ that represents the most conservative critical load. By the post-closure case, sources of nitrogen emissions, such as mining operations and associated vehicular activity, will have stopped (**Table 5.4.6-17**).

The ecological context is high, as residual N in the soil may continue to impact whitebark pine or its habitat. The magnitude is low and geographic scale local. The duration of the effect is long-term, lasting from construction through operations to closure and reclamation, but is expected to be reversible over time with the cessation of N deposition. The likelihood is moderate as the persistence of N in ecosystems is well documented and the confidence of the likelihood is moderate. Significance is minor because the effect may remain through post-closure. The level of confidence for significance is moderate.

Table 5.4.6-17: Potential Residual Effects Significance of Nitrogen Deposition on Whitebark Pine

Effect Attribute	Post-Closure
Context	high
Magnitude	low
Geographic extent	local
Duration	long-term
Reversibility	yes
Frequency	once
Likelihood Determination	moderate
Level of confidence for likelihood	moderate
Significance determination	Not Significant (minor)
Level of confidence for significance	moderate

5.4.6.4.1.3 Whitebark Pine Regeneration

The potential effects of whitebark pine regeneration cannot be quantified at this time, and therefore the significance ranking is based on qualitative information and expert opinion (Barringer et al., 2012; Clason, 2013, Clason and Moody, 2013; Hutchins, 1982; Keane et al., 2011; McKinney, 2009; Schwandt, 2010; Tomback, 2005). The wildlife assessment (Forest and Grassland Birds VC, **Section 5.4.9**) is recommending monitoring and adaptive management of Clark's nutcracker populations. The vegetation and wildlife teams will work collaboratively to assess and address potential impacts.

Assessment of potential residual effects significance for whitebark pine regeneration on whitebark pine is provided in **Table 5.4.6-18**.

By the Post-closure Case, buildings and infrastructure will have been removed and reclamation measures initiated. The ecological context is high because the Project may result in long-term to permanent effects on a SARA-listed species. The magnitude is medium because there is an 11% reduction of the original population. Geographic extent is local as effects are likely limited to the local whitebark pine population. The duration is chronic, as it will take up to 80 years to restore seed-producing whitebark pine populations. The reversibility is highly dependent on reclamation with rust-resistant trees, but is considered reversible. The frequency of the loss will be once. The determination of likelihood and level of confidence for likelihood are ranked as moderate. The significance of the residual effect is rated Not Significant—moderate because successful reclamation will likely foster Clark's nutcracker populations. The level of confidence for significance is low, as the response of Clark's nutcrackers to reduced whitebark pine numbers is likely negative (Barringer, 2012).

Table 5.4.6-18: Potential Residual Effects Significance of Whitebark Pine Regeneration on Whitebark Pine

Effect Attribute	Post-Closure
Context	high
Magnitude	medium
Geographic extent	local
Duration	chronic
Reversibility	yes
Frequency	once
Likelihood Determination	moderate
Level of confidence for likelihood	moderate
Significance determination	Not Significant (moderate)
Level of confidence for significance	low

5.4.6.5 Cumulative Effects

The residual effect of ecosystems loss, nitrogen deposition and whitebark pine regeneration for the Plant Species and Ecosystems at Risk VC will be carried forward into the Cumulative Effects Assessment (CEA). A cumulative effect occurs if a Not Significant (minor) or Not Significant (moderate) residual effect for the Project occurs. **Table 5.4.6-19** provides the rationale for carrying the effect forward into the CEA.

Table 5.4.6-19: Summary of the Significance, Rationale, and Cumulative Effect of Historical, Current, and Future Land Use Effects

Indicator	Project Phase	Potential Residual Effect	Historical Land Use				Representative Current and Future Land Use							Reasonably Foreseeable Projects		Carried Forward into CEA
			Recreational (trails, fishing and lodges)	Forestry (cut blocks and woodlots)	Aboriginal traditional use	Trapping and guide outfitting	Mining (activities, current prospecting, quarries)	Recreational (sites, trails, fishing and lodges)	Forestry (cut blocks and woodlots)	Aboriginal traditional use	Trapping and guide outfitting	Agriculture (Present)	Natural disturbance (Fire and MPB)	Nulki Hills Wind Project	Agriculture (pending range tenures)	
Whitebark pine	C, O, D/C, PC	Ecosystem loss	I	I	I	I	I	I	I	I	I	I	KI	NI	NI	yes
		Nitrogen deposition	NI	NI	NI	NI	I	NI	NI	NI	NI	NI	NI	NI	NI	yes
		Whitebark pine regeneration	NI	NI	NI	NI	I	NI	NI	NI	NI	NI	KI	NI	NI	yes
Potential plant species at risk habitat	C, O, D/C, PC	Ecosystem loss	NI	I	I	NI	I	NI	KI	I	I	I	KI	NI	NI	yes
		Nitrogen deposition	NI	NI	NI	NI	I	NI	NI	NI	NI	NI	NI	NI	NI	yes

Note: I = interaction, KI = key interaction, NI = no interaction

5.4.6.5.1 Interactions between Plant Species and Ecosystems at Risk VC and other Past, Present, or Future Project/Activities

A number of projects and human activities contain spatial overlap with the proposed features of the Project. These include recreational activities, forestry activities, transportation and access, mining activity, trapping and guide outfitting, traditional land use, and other projects. Natural disturbance such as wildfires and MPB interact with the Project. MPB was observed to be widespread across the RSA. Attack severity and status are discussed in the Non-traditional Land and Resource Use (**Section 7.2.6**).

Some of these activities can be quantified, and include the Nulki Hills Wind Project, mining activity (quarries and prospecting), and past, present and future forestry activity. The maximum interaction occurs with potential plant species at risk habitat, roughly 8,080 ha of overlap between past, present, and foreseeable future with potential plant species-at-risk habitat (**Table 5.4.6-20**). There is minimal (<1 ha) overlap between whitebark pine and other projects and activities, but whitebark pine is surrounded by and overlaps with 59 ha (6%) of MPB attack severity rating of Severe (greater than 31% of VRI stand affected). The current infection rate of whitepine blister rust is at 32% of the total whitebark pine distribution.

Table 5.4.6-20: Spatial Overlap by Project/Activity: Potential Plant Species-at-Risk Habitat

Project	Spatial Overlap with Terrestrial RSA	Temporal Overlap with Terrestrial RSA	Amount of Overlap (ha)
Nulki Hills wind project	Yes	Yes	876
Mining activity*	Yes	Yes	136
Forestry	Yes	Yes	7,068
Total			**8,080**

5.4.6.5.2 Mitigation Measures and Potential Residual Cumulative Effects

Forestry-related and mining activities in the Project area will be removing and altering plant species and ecosystems at risk VC including nitrogen deposition from vehicles and equipment. The primary means to mitigate the effects of forestry operations will be by continuing to follow forest harvest guidelines (including cut block and road design) to minimize erosion and maximize reforestation, and by implementing invasive plant control measures and monitoring systems. An element of uncertainty persists however in re-establishing plant species at risk habitat because some sites may experience higher success than others depending on site-specific conditions.

The primary means to mitigate the effects of mining activity will be to minimize the footprint and implement mitigation measures reducing the spread of invasive plants species. The mountain pine beetle infestation is widespread. Similar to forestry practices mitigation measures will maximize reforestation, encourage natural regeneration and implement invasive plant control measures. Stands with a low proportion of pine affected by MPB and not harvested remain as altered but functioning ecosystems on the landscape. Whitepine blister rust mitigation will involve a multi-step

/ multi-agency process whereby a rust screening program is established to identify and plant rust resistant whitebark pine trees.

5.4.6.5.3 Significance of Potential Residual Cumulative Effects

Table 5.4.6-21 summarizes the residual cumulative effects on the Plant Species and Ecosystems at Risk VC. The effects of ecosystem loss for whitebark pine and potential plant species at risk habitat were combined and considered together for the assessment. In addition, the assessment considers all Project phases. The table shows the CEAs both with and without the Project contribution. The ecological context is high because the Project may result in long-term to permanent effects on a *SARA*-listed species. Given the extent of MPB attack and white pine blister rust, the magnitude is considered high. Whitebark pine is affected province-wide hence the regional rating. The duration is over many years and chronic in both scenarios. The effects are likely to be reversible with reclamation, mitigation and reforestation for potential plant species at risk habitat but less likely for whitebark pine. Therefore, the level of confidence is low.

With the Project added, the magnitude, geographic extent, duration, and frequency remain the same. The Project adds irreversible ecosystem loss as a cumulative effect. The effects are likely to be reversible on natural landform types but not reversible on mine-related landform types. The widespread forestry activity in the Project area results in a regional effect. With the proposed mitigation for whitebark pine, rust-resistant trees will be re-established and monitored. For this reason, the significance ranking is Not Significant (moderate), but with a low confidence because of the level of uncertainty related to whitebark pine mitigation.

Table 5.4.6-21: Significance of Potential Residual Cumulative Effects on Plant Species and Ecosystems at Risk

Parameter	Current/Future Cumulative Environmental Effect without Project	Cumulative Environmental Effect with Project
Ecosystem Loss		
Effect Attribute		
Context	high	high
Magnitude	high	high
Geographic extent	regional	regional
Duration	chronic	chronic
Reversibility	yes	natural landforms –yes mine-related - no
Frequency	continuous	continuous
Likelihood Determination	moderate	moderate
Level of Confidence for Likelihood	High	High
Significance Determination	Not Significant (moderate)	Not Significant (moderate)
Level of Confidence for Significance	low	low

Note: refer to **Section 4.3.6** for assessment criteria

5.4.6.6 Limitations

Limitations are inherent with the production of a whitebark pine distribution map and an ecosystem map meant to represent the baseline condition, and which forms the foundation of the environmental assessment. Every attempt was made to produce as reliable and accurate a map product as possible, following standard protocols and best management practices.

5.4.6.7 Conclusion

The primary effect of the Project to the plant species and ecosystem at risk VC will be the loss of baseline ecosystems, dust, N deposition, and the potential spread of invasive plant species. For whitebark pine Project effects on whitebark pine regeneration is an additional influence. Mitigation measures to address these effects include optimization of the Project footprint, which occurred during the design phase, and implementing relevant management plans, including the 5 Year Whitebark Pine Management Plan, Air Quality and Emissions Management Plan, Transportation and Access Management Plan, Erosions and Sediment Control Plan, Landscape, Soil, and Vegetation Management and Restoration Plan, ISMP, and Wildlife Management Plan.

To further mitigate the effects of whitebark pine loss, mitigation will include a range of strategies including avoiding loss through project design, replanting, progressive reclamation and supporting research. Further discussion with regulatory agencies is anticipated to refine the research components to ensure the maximum benefit is derived from the work. Commitments include: increasing awareness, population inventory, rust screening, cone collection, reclamation trials, off-site transplanting and stand enhancement. Monitoring will be on-going through the life of the mine.

Ecosystem loss of whitebark pine and potential plant species-at-risk habitat was ranked as Not Significant (moderate). The effect of N deposition was ranked Not Significant (minor) as only a small area was expected to be impacted and the effect to species and ecosystems at risk likely to diminish over time. The effect of whitebark pine regeneration was ranked as Not Significant (moderate) because successful reclamation will likely foster Clark's nutcracker populations

Cumulative effects and mitigation measures of forestry activities, mining, and a wind project were assessed for the RSA. Mountain pine beetle and white pine blister rust affect whitebark pine populations province-wide, and therefore the magnitude with or without the Project is high. When considering the cumulative contribution of project effects, the magnitude, geographic extent, duration, and frequency remain the same. The Project adds irreversible ecosystem loss as a cumulative effect. The effects are likely to be reversible on natural landform types but not reversible on mine-related landform types; therefore, the effects were ranked Not Significant (moderate) for Plant Species and Ecosystems at Risk VC.