PROSPERITY
A Gold-Copper Project of Taseko Mines Limited

Taseko Prosperity Gold-Copper Project

Appendix 5-5-L

Taseko Mines Limited

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Grasslands of the Southern Cariboo and Taseko Areas

1 Introduction

Grasslands are found throughout British Columbia, and vary widely due to the province's diverse geology, topography and climate (Fontaine and Douglas 1999). In the Taseko project area grasslands are common in all three of the mapping areas. However, they are most frequent in the proposed transmission line corridor which spans the Fraser River, an area particularly well known for its large grasslands. Grasslands are considered to be threatened ecosystems in British Columbia, covering about 1.8 percent of the province (Fontaine and Douglas 1999).

Grasslands are generally defined as semi-arid ecosystems dominated by bunchgrasses, shrubs, and forbs (non-grass plants), occurring in the hottest, driest locations on the landscape. Trees do not grow well due to the long summer droughts, while grasses are well adapted to capturing small amounts of moisture. For this project, this grassland definition has been expanded to include higher elevation pocket grasslands and moist grass/herb meadows. Moist meadows occur on gently sloping areas adjacent to wetlands, or in cold-air pockets in valley bottoms and close to streams, particularly in the IDFdk3, IDFdk4, and SBPSxc subzones. Full grassland descriptions are given in subsequent sections.

2 Background Information

2.1 Rangeland

Large grasslands and open rangeland occurs primarily in three subzones: the Fraser Very Dry Hot Variant of the Bunchgrass Zone (BGxh3), the Alkali Very Dry Warm Variant of the Bunchgrass Zone (BGxw2), and the Very Dry Mild Subzone of the Interior Douglas Fir Zone (IDFxm). Grasslands in these three subzones are often referred to as the Lower Grasslands, Middle Grasslands and Upper Grasslands, and roughly correspond with the three subzones mentioned.

The Lower Grasslands (BGxh3) occur from the lowest elevations of the Fraser River valley up to about 650 m on lower and middle valley slopes. Sagebrush is common in these grasslands. The Middle Grasslands (BGxw2) occur from about 650m to 900 m. Sagebrush is uncommon and, as in the Lower Grasslands, conifer forests are generally restricted to north-facing slopes and moist ravines. The Upper Grasslands (IDFxm) generally occur at elevations above 900 m. These grasslands occur in a transition zone between a predominantly grassland landscape at lower elevations and a predominantly forested landscape at higher elevations. Grasslands also occur in the other biogeoclimatic units in the project area (IDFdk3, IDFdk4, SBPSxc, and MSxv), but most often on south-facing slopes that are too dry for trees or in cold air accumulation basins that are too cold for trees.

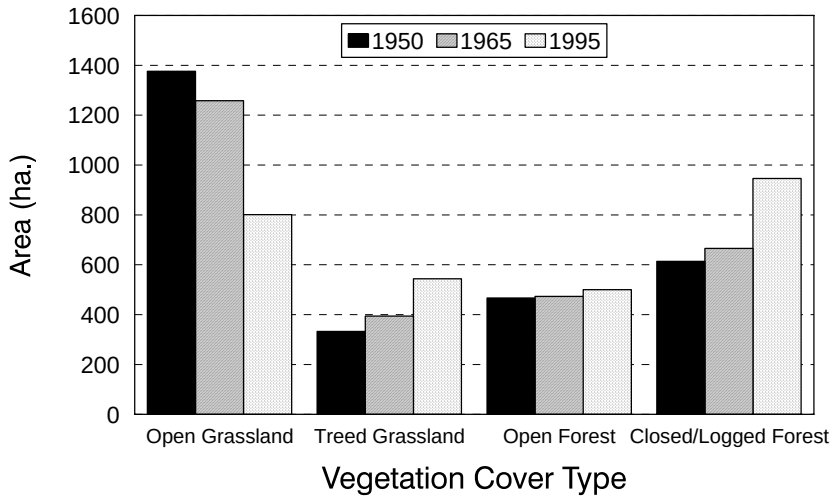
2.1.1 Forest Encroachment in Grasslands

Over the last 60 years, forest encroachment and in-growth have significantly reduced the area of grasslands and open forests in the Cariboo-Chilcotin (including the proposed transmission corridor). Forest encroachment, defined as the advancement of trees and other forest vegetation onto previously open grasslands, is reducing the area of grasslands while forest in-growth, the filling-in of open forests by tree regeneration, has greatly increased shading and resulted in reduced vigour and abundance of herbaceous vegetation under previously open-grown trees (Cariboo-Chilcotin Grasslands Strategy Working Group 2001).

The Cariboo Grassland Strategy Committee has assessed several grassland areas within the Transmission Corridor area for forest encroachment. The first area assessed includes approximately 2800 ha on the west side of the Fraser River in the Word Creek drainage. It includes the Lower Grasslands (BGxh3) adjacent to the Fraser River and extends westward for approximately 5 km up to the continuous Douglas-fir forests in the IDFxm subzone. Slopes are predominantly east facing. A comparison of three dates of aerial photography (1950, 1965, and 1995) was used to assess changes in the area of closed forest, open forest, treed grassland, and open grassland cover types.

Results from the assessment of the Word Creek area are consistent with results from other areas reported by Ross (1997). From 1950 to 1995, the area of open grassland decreased by an estimated 42%, from 1376 ha to 801 ha (Figure 2-1). The greatest rate of change in area of open grassland was in the 1965 - 1995 period. The areas of forest and treed grassland all increased, with the greatest increase in the area of closed/logged forest. Forest encroachment was predominantly in upper elevations of the area, in the IDFxm and upper elevations of the BGxw2.

Figure 2-1 Changes in the Area of Forests and Grasslands in the Word Creek Area from 1950 to 1965 and 1995



The second area assessed by the Grassland Strategy Committee is also in the proposed Transmission Corridor, across the Fraser River from the Word Creek area and just south of Meason Creek. The assessed area, about 2,000 ha, extends from the Lower Grasslands (BGxh3) adjacent to the Fraser River into the Upper Grasslands (IDFxm) on the plateau

east of the Fraser River valley. Douglas-fir forests are extensive at the upper elevations of the area. The assessments of this area were based on comparisons of 1974 and 1995 aerial photographs.

The pattern and rate of forest encroachment, and consequent reduction in the area of open grassland in the Meason Creek area was similar to, but smaller, than in the Word Creek area. In the 20 years between the two dates of photography, the area of open grassland decreased by about 11%, from approximately 1201 to 1068 ha for an average annual rate of decrease of 0.5%.

In summary, the various reasons for forest encroachment include:

- macro and micro-climate fluctuations (e.g., a wet spring);
- fire control, including cessation of aboriginal burning;
- overgrazing; and
- cycles of conifer seed production.

2.1.2 Implications of Climate Change

The section above outlines the various factors explaining forest encroachment into grasslands, but the effects of climate change was not mentioned in literature. While beyond the scope of this report to discuss climate change in detail, it is useful to mention some of the predicted future changes to grassland size and distribution. Grasslands across the landscape will respond in different ways to climate change, but some possibilities are described below:

- Shrubs will invade and, in some cases, replace native grasslands (Stelljes et al. 1997).
- A drier, hotter climate resulting from global warming will likely alter the grassland habitat, adding stress to already declining populations of wildlife that depend on it (National Wildlife Federation Newsletter November 2006).
- Climate change may expand the size of existing grasslands (reduced forest encroachment) as the average global temperature climbs. From Rachel Van Caeseele in “Prairie Breeze”, the Manitoba Living Prairie Museum Newsletter, Winter 2004.
- Boreal forests may slowly become grasslands and grasslands may turn into deserts over time (The Pembina Foundation, Newsletter 2007).

2.1.3 Biodiversity

There is a high diversity of plant species in grasslands, but there are also a great variety of mammal, bird, amphibian, reptile and insect species that use these habitats. There are species that depend on late seral grasslands and those that prefer early seral. However, for birds, there is evidence that overall diversity and flock sizes are greatest in ungrazed or lightly grazed grassland systems (Hooper and Pitt 1995). Similarly, butterfly diversity appears to be greatest in grassland ecosystems that retain natural fire events and are only lightly grazed (C. Guppy, in Hooper and Pitt 1995).

2.1.4 Biological Soil Crusts

A less obvious feature of grasslands is the fragile crust of lichens, mosses, and algae alternatively known as biological soil crusts, microbiotic crusts, or simply lichen crusts.

Soil crusts are made up of, to a large extent, squamulose and crustose lichens such as *Placidium* and *Psora*, and of nitrogen-fixing lichens such as *Collema tenax*, *Peltula spp.*, *Xantoparmelia wyominica*, and *Diploschistes muscorum* (Brodo and Sharnoff 2001). This soil crust, found most frequently in undisturbed or lightly grazed grasslands, performs many important soil functions including:

Soil stabilization: the soil crust binds the soil together thus minimizing wind and water erosion. Some of the organisms secrete sticky substances (polysaccharides), which hold soil particles together (fungi and algae often secrete polysaccharides as an adaptation to help them adhere to surfaces and to prevent them from drying out [Brodo and Sharnoff 2001]).

Enhancing water capture: biological soil crusts may help the soil retain more moisture. The extent to which this function occurs is highly dependent on both the composition of the crust and soil characteristics (Iverson 2004).

Increased soil fertility: biological soil crusts make the soil more fertile by providing nitrogen to plants. Some cyanobacteria and lichens fix atmospheric nitrogen, even during the winter. Soil crusts can make other nutrients more available for use by grasses, forbs, and shrubs, as nutrients adhere to the polysaccharides (which have very large, often branched molecules), and are prevented from leaching away. Microbiotic crusts provide the major share of fixed nitrogen in desert ecosystems.

Addition of organic carbon to topsoil: most of the organisms associated with the biological soil crust are photosynthetic, particularly during cold, wet seasons when most plants are dormant. This means that the biological soil crust increases the length of the time during which organic carbon is added to topsoil.

Natural prevention of establishment of invasive plants: The nature of the crust itself can prevent some invasive plants from becoming established. Native plants, which have evolved with biological soil crusts, may have developed mechanisms to allow seeds to penetrate the crust (e.g., small size, or awns that "drill" the seed into the crust). Seeds of some invasive species are quite large and may not have a way of getting through the crust. The seeds of invasive plants have a better chance of germinating where the soil crust has been damaged and erosion and/or exposed mineral soil is present (Brodo and Sharnott 2001).

Due to their functions in rangeland ecosystems, biological soil crusts have been adopted by scientists and land management professionals in the U.S., Australia, and South Africa as visible indicators of rangeland health (Belnap et al. 2001).

2.1.5 Summary

Grasslands are important to local communities and resource users, and are also important regionally, provincially, and nationally. Due to their importance and high visibility, residents of the area people have concerns and feel strongly about grasslands (Hooper and Pitt 1995). Concerns about loss of grassland include loss of forage and biodiversity.

Direct or indirect damage to grasslands can occur through intensive livestock grazing, motorized recreational impacts, and agricultural and land development, range seeding, alien plant and animal introductions, predator control and hunting (Hooper and Pitt 1995). Introduced plants such as knapweed and cheatgrass have invaded many types of grassland in the Cariboo region.

In summary, grasslands:

- harbour rare plants;
- provide important wildlife habitat;
- contribute to biodiversity with their unique plants;
- are used by local First Nations for traditional purposes;
- have unusual lichens and mosses;
- provide grazing and rangeland for domestic animals;
- have high hunting values;
- provide recreational opportunities such as walking, hiking, bird watching, photography;
- have high aesthetic value; and
- are the object of scientific study and range management.

2.2 Grassland Mapping

2.2.1 Field Work and Methodology

Grassland sampling was done in tandem with other vegetation fieldwork however an effort was made to visit as many grassland types as possible. Mapping used the existing mapping done by Madrone (Madrone 1999).

Standard ecological data was collected within each sampled grassland. This includes location, slope, aspect, elevation, landform, soil type and texture, plant lists, and wildlife notes (RIC 1998).

Some grassland types are listed as Ecosystems of Conservation Concern and are described as so in the accompanying report (Appendix B.2). Rare grasslands are described by the BC Conservation Data Centre (CDC 2006).

2.2.2 Classification

The grassland classification used during field work followed that described in the unpublished drafts from the Research Section, Cariboo Forest Region (Iverson and R. Coupé 1996A; Iverson and R. Coupé 1996B; and Iverson and Steen 1996).

Ecosystem mapping contract reports for Becher's Prairie, Dog Creek, and Chilcotin River grasslands were consulted for their descriptions of grassland types (Clement C. and U. Lowrey 1998A and B; and Lowrey 1998A and B). For partially forested sites, the field guide for the Cariboo Forest Region was used (Steen and Coupe 1997).

A revised grassland classification prepared by research section staff is currently in draft form (Ray Coupe, pers. comm.), however field work for this project was done prior to its availability.

Grasslands have also been classified under the Sensitive Ecosystem Standards (RIC 2006). However this is a more general classification, with the different units separated based on slope, soil depth, disturbance, and bunchgrass or shrub dominated.

2.2.3 Results

The largest, most expansive grasslands were found in the hotter, lower elevation subzones (BGxh3, BGxw2, and IDFxm) close to the Fraser River. Grasslands at higher elevations (IDKdk3, IDFdk4, SBPSxc) are common, but smaller, generally occurring either on warm slopes, on coarse soils, or adjacent to wetlands. A total of 21 different grassland types were found and mapped. The total area of all grassland types was 2401 ha, or 2.09% of the total mapping area. The subzone with the greatest number of grassland types was the IDFdk3 with six.

2.2.3.1 Summary of Grasslands for each Mapping Area

Minesite Grasslands

The proposed minesite is near Fish Lake and occurs in a submontane area with a cool, but fairly dry climate. Grasslands are small and localized on crest positions and warm aspects, and on rich alluvial fans adjacent to Fish Creek. Upland grasslands often have high cover of dwarf shrubs such as kinnikinnick and common juniper, as well as lichens and herbs such as pussytoes. Grasslands on alluvial fans have a wide array of wildflowers as well as grass species.

Transmission Corridor Grasslands

The transmission corridor has a large variety of grassland ecosystems, due to the varied terrain it covers, ranging from the submontane areas close to Fish Lake, through the Big Creek area, and as far as Dog Creek on the east side of the Fraser River. The largest, most expansive grass and rangelands are found in the hotter, lower elevation biogeoclimatic subzones close to the Fraser River (BGxh3, BGxw2, IDFxm).

Access Road Grasslands

The largest variety of grassland ecosystems along the access road is in the IDFxm subzone near the Chilcotin River, where the elevation is lower and the climate warmer. In both the Tete Angele Creek and Taseko River areas, grasslands occur on the warm aspects of ravines. Seasonally moist grasslands are also frequent on gently sloping areas adjacent to wetlands or meandering creeks. Grassland ecosystems at higher elevations in the access road are common, but smaller, generally occurring either on warm slopes, on coarse soils, or adjacent to wetlands.

Table 2-1 List of Mapped Grassland Ecosystems–All Vegetation RSAs

Grassland Ecosystem	Biogeoclimatic Unit	Site Series Number/Wetland Code	TEM Map Code	Elevation Class	Growth Form	Moisture Status	Invasive Plant Risk Class	CDC Listing Status	Grassland Sensitivity Class
Alkali saltgrass - Nuttall's alkaligrass	IDFxm	Gs01	GR	B	Grass/forb	moist	a	**red**	**1**
Baltic rush - Field sedge meadow	IDFdk4	Gs03	RS	B	Grass/forb	moist	a	**blue**	**1**
	SBPSxc	Gs03	RS	B	Grass/forb	moist	a	**blue**	**1**
Big sagebrush - Sand dropseed	BGxh3	33	SS	A	shrubby	dry	a	**red**	**1**
Bluebunch wheatgrass - Balsamroot	IDFdk4	00	WB	B	Grass/forb	dry	a	**red**	**1**
Bluebunch wheatgrass - Big sagebrush	BGxh3	01	SW	A	Grass/forb	dry	a	**red**	**1**
	BGxw2	01	SP	A	Grass/forb	dry	a	**red**	**1**
Bluebunch wheatgrass - Needle-and-threadgrass	BGxw2	01	WN	A	Grass/forb	dry	a	**blue**	**1**
Nuttall's alkaligrass - Foxtail barley	IDFdk3	Gs02	AF	B	Grass/forb	moist	a	**red**	**1**
	IDFdk4	Gs02	AF	B	Grass/forb	moist	a	**red**	**1**
Short-awned Porcupinegrass – Wormwood - Pussytoes	IDFxm	34	PP	B	Grass/forb	dry	a	**red**	**1**
Big Sagebrush - Prickly pear cactus	BGxh3	31	SC	A	shrubby	dry	a		**2**
Bluebunch wheatgrass - Nodding onion	BGxw2	00	WO	A	Grass/forb	dry	a		**2**
Bluebunch wheatgrass - Pasture sage	BGxh3	00	WD	A	Grass/forb	dry	a		**2**
	BGxw2	00	PW	A	Grass/forb	dry	a		**2**
	IDFxm	00	WP	A	Grass/forb	dry	a		**2**
	IDFdk3	00	WP	A	Grass/forb	dry	a		**2**
	IDFdk4	00	WP	A	Grass/forb	dry	a		**2**
	BGxh3	00	WS	A	Grass/forb	dry	a		**2**
Bluebunch wheatgrass - Round-leaved alumroot	BGxh3	39	WA	A	Grass/forb	dry	a		**2**
Short-awned porcupinegrass - Lemonweed	BGxw2	38	PL	A	Grass/forb	dry	a		**2**
Bluebunch wheatgrass - Yarrow	IDFdk3	00	WY	B	Grass/forb	dry	a		**3**
	IDFxm	00	WY	B	Grass/forb	dry	a		**3**
Grass - Large-leaved avens	SBPSxc	00	GA	B	Grass/forb	moist	b		**3**
Grass - Large-leaved avens	IDFdk4	00	GA	B	Grass/forb	moist	b		**3**
Spreading needlegrass - Baltic rush	IDFdk4	00	NR	B	Grass/forb	moist	a		**3**
	IDFxm	00	NR	B	Grass/forb	moist	a		**3**
Spreading needlegrass - Pussytoes	IDFxm	00	NP	B	Grass/forb	dry	a		**3**

Grassland Ecosystem	Biogeoclimatic Unit	Site Series Number/Wetland Code	TEM Map Code	Elevation Class	Growth Form	Moisture Status	Invasive Plant Risk Class	CDC Listing Status	Grassland Sensitivity Class
	IDFdk3	00	NP	B	Grass/forb	dry	a		**3**
Spreading Needlegrass - Sticky Purple Geranium	IDFxm	37	NG	B	Grass/forb	dry	a		**3**
Bluebunch wheatgrass - Junegrass	MSxv	00	WJ	C	Grass/forb	dry	b		**4**
Dandelion - Timber oat-grass	IDFdk4	00	DT	B	Grass/forb	moist	b		**4**
	SBPSxc	00	DT	B	Grass/forb	moist	b		**4**
Juniper - Kinnikinnick	MSxv	00	JK	C	shrubby	dry	c		**4**
	SBPSxc	00	JK	C	shrubby	dry	c		**4**
Rocky Mtn. juniper - Rabbitbrush	BGxh3	35	JR	A	shrubby	dry	b		**4**

NOTE: 1) Some grasslands occur in more than one BEC unit; 2) Definitions for codes in table are found in Section 4.

3 Descriptions of Mapped Grasslands in the Taseko Mines Project Area

Rocky Mountain Juniper/Rabbitbrush (BGxh3)

This grassland occurs on steep (>65%) east-facing slopes with eroded regosolic soils that are typically calcareous. Exposed mineral soil dominates on these sites (70-90% cover) and vegetation is limited to widely scattered bluebunch wheatgrass clumps, pasture sage, pulse milk-vetch and pale comandra. Widely scattered Rocky Mountain juniper, rabbitbrush, saskatoon, big sagebrush and occasional small Douglas-fir trees are also usually present. Mosses and lichens are virtually absent. This unit is very uncommon occurring in widely distributed small patches near the Fraser River. Due to limited access, most sites are undisturbed.

Bluebunch Wheatgrass/Big Sagebrush (BGxh3/BGxw2)

This grassland ecosystem occurs on level to moderate slopes on all aspects on hot, lower elevations immediately adjacent to both banks of the Fraser River. Soil textures are predominantly fine sandy to loamy. Vegetation cover is dominated by vigorous, well-spaced clumps of bluebunch wheatgrass. Big sagebrush is also abundant on sites that have not recently been burned. Other common plant species include junegrass, pussytoes, pasture sage, prickly pear cactus, northern fairy-candelabra and lemonweed. Total plant cover is moderate to high but generally made up of relatively few species. Lichens, mosses and blue-green algae form a well-developed crust in the spaces between vascular plants. This crust includes low covers of mosses (such as *Tortula* sp. and *Hypnum* sp.) and a well-developed lichen component dominated by *Cladonia cariosa, C. pyxidata* and *C. symphicarpa* with lesser amount of *C. chlorophaea, C. gracilis* and *C. phyllophora*. Pelt lichens (including *Peltigera didactyla, P. canina, P. ponojensis* and *P. rufescens*) are most common on steep east and steep northerly slopes. In addition, seral lichens (*Diploshisties muscorum, Psora spp., Caloplaca sp.* and *Collema* spp.) are present with low cover. South and west hot aspects usually have lower covers of bluebunch wheatgrass and are slower to recover from disturbance than steep east and northwest aspects. This grassland was only mapped in the transmission corridor RSA, where it occurs as large areas of rangeland. On the east side of the Fraser River, the most common disturbance in this grassland type is cattle grazing, whereas on the west side these ecosystems are relatively inaccessible and largely undisturbed.

Figure 3-1 Bluebunch Wheatgrass/Big Sagebrush

Big Sagebrush/Prickly-pear Cactus (BGxh3)

This grassland ecosystem occurs on hot, dry locations close to the Fraser River. It is frequently found on gently sloping benches and terraces, or shallow soils over bedrock where soils are stable. Moisture status is very xeric to subxeric. Scattered big sagebrush is common, and distinguished by patches of prickly-pear cactus. Other plants include bluebunch wheatgrass, junegrass, pussytoes, pasture sage, northern fairy-candelabra and lemonweed. This unit is common within the BGxh3; often occurring as smaller patches within a matrix of larger ecosystem units such as BGxh3/Big sagebrush–Bluebunch wheatgrass. Due to easy access, many sites are partially disturbed by grazing, and in some cases, by recreational vehicles.

Big Sagebrush/Sand-dropseed/Needle-and-thread Grass (BGxh3)

This grassland ecosystem occurs on exposed slopes with warm aspects close to the Fraser River in the transmission corridor. Soils are typically sandy textured and the moisture regime is xeric to subxeric. Total plant cover and diversity are low and typical species include scattered big sagebrush, sand-dropseed grass, widely scattered bluebunch wheatgrass, needle-and-thread grass, junegrass, lemonweed and cut-leaved anemone. Lichens and mosses are absent. This unit is very uncommon; occurring in widely distributed small patches on eroding slopes, banks, small and localized sand dunes. The majority of these grasslands are undisturbed due to poor access.

Bluebunch Wheatgrass/Round-leaved Alumroot (BGxh3)

This grassland ecosystem is found in the transmission corridor RSA on steep slopes with cool (north and northeast) aspects close to the Fraser River. Late seral and climax vegetation is dominated by abundant and vigorous bluebunch wheatgrass. A well-developed litter layer typically occurs between the bunchgrass and exposed mineral soil is minimal. Common plant species include junegrass and a relatively high diversity of forbs (including pussytoes, yarrow, northern fairy-candelabra, salsify, round-leaved alumroot, spike-like goldenrod, mariposa lily, western blue flax, old man's whiskers, woolly groundsel and cut-leaved anemone). The cryptogam layer is typically well developed and fills nearly all available space (30-90% cover) between vascular plants. This layer is dominated by several *Cladonia* spp. and includes some *Tortula* sp., *Diploschistes muscorum*, *Gimmia* sp. and scattered pelt lichens. Several lichens such as *Psora* spp. and *Collema* sp. are rarely present on these and other north aspect sites. This unit can be distinguished from steep E and NW slopes (BGxh3/01) by a much greater diversity of herbs and less big sagebrush. Also, round-leaved alumroot, old man's whiskers, woolly groundsel, and spike-like goldenrod are more common on these sites. This unit is uncommon; occurring in fairly widely distributed small patches on cool, steep slopes. Due to poor access to these sites, most remain undisturbed.

Short-awned Porcupinegrass/Lemonweed (BGxw2)

This unit is found in the transmission corridor on warm aspects close to the Fraser River where it occurs in moist, very shallow depressions and shallow swales where runoff accumulates on hillsides. Snow often lies later in these shallow depressions than on surrounding areas. These sites are generally very small (often <100 m2) but are very common and widely distributed in the BGxw2. They typically occur as inclusions within a matrix of other grasslands ecosystems. Plant communities are dominated by a dense cover of short-awned porcupinegrass (50-85%). A thick litter layer is usually present. Vegetation also includes occasional bluebunch wheatgrass, junegrass and pasture sage, as well as a scattering of several forbs (including lemonweed, salsify, yarrow, pussytoes and sagebrush mariposa lily). Lichen cover is generally low (1-30%), due to the thick, matted grass litter covering the ground. Dominant lichen species include *Cladonia* spp. (*C. cariosa, C. pyxidata, C.chlorophaea, C.gracilis,* and *C.macrophylla*) and occasionally a few pelt lichen clumps. The area of exposed soil is usually less than 5%. This unit is common within the subzone, often occurring as small patches within a matrix of larger units such as BGxh3/Big sagebrush – Bluebunch wheatgrass. Due to easy access, many sites are disturbed by grazing and sometimes by recreational vehicles.

Bluebunch Wheatgrass /Needle-and-thread Grass (BGxw2)

This grassland ecosystem occurs on level and gently rolling sites above 880m the transmission corridor RSA in areas close to the Fraser River where it occurs. It differs from the BGxh3/Big sagebrush-Bluebunch wheatgrass, having more vigorous bluebunch wheatgrass, sparse or absent needle-and-thread grass, brittle prickly-pear cactus and western blue flax and the greater abundance of forbs. It is transitional to the IDFxm grasslands. Other forbs include pussytoes, northern wormwood, nodding onion, yarrow, spike-like goldenrod, trailing fleabane, yellow owl-clover, round-leaved alumroot, sagebrush mariposa lily, woolly groundsel, death camas and lance-leaved stonecrop. Lichens are common, including a greater diversity of pelt lichens (especially *Peltigera rufescens, Peltigera didactyla* and *Peltigera ponojensis*). The area of exposed, soil is

generally less than 15%. This unit is common within the BGxw2, often occurring in large contiguous patches. Due to easy access, most sites are at least partially disturbed by livestock and sometimes off road vehicles.

Short-awned Porcupinegrass/Wormwood/Pussytoes (IDFxm)

This grassland ecosystem occurs on level to gentle slopes benches and terraces above the Fraser River. Soils are typically deep, medium textured, often with a capping of aeolian (wind-blown) soil and moisture status is mesic to submesic. A dense cover of short-awned porcupine grass with abundant grass litter is typical. Other plants include scattered bluebunch wheatgrass, junegrass, lemonweed, salsify, yarrow, pussytoes, pasture sage and sagebrush mariposa lily. Lichen cover is generally low, due to the thick, matted grass litter covering the ground. This unit is uncommon within the subzone, often occurring as small patches. Due to unstable soils, this grassland is susceptible to disturbance.

Bluebunch Wheatgrass/Junegrass (MSxv)

These grassland ecosystems have developed on weathered basalt outcrops where soil development is minimal and humus is non-existent. These crest position sites are xeric or sub-xeric with rapid drainage. Soil textures are a sandy clay loams with a high percentage of coarse fragments. Vegetation often covers less than 50% of the ground. Bluebunch wheatgrass and junegrass are consistently present, although cover is low. Dwarf shrubs include common juniper and kinnikinnick. Flowering herbs are sparse but include saxifrages, yarrow, cut-leaf daisy, pinegrass, Jacob's ladder, *Astralagus miser*, goldenrod, *Carex concinna* and rosy, field and Nuttall's pussytoes. Lichens and compact selaginella are also common. *Cladonia* species can be common while crustose lichens and rusty steppe moss are scattered. This unit was only mapped in the minesite area, and occurs as small patches on localized rock outcrops and crest positions adjacent to forested areas. Disturbances are low due to remoteness and poor access.

Juniper/Kinnikinnick (SBPSxc, MSxv)

These dry grassland ecosystems usually occur on crest positions and warm aspect slopes of the fluvioglacial kames and eskers that dot the landscape as well as steep warm slopes of morainal or colluvial deposits. Slopes vary from 5% on crests to up to 65% on the warm aspect slopes. Soils are well drained with some coarse fragments but little humus development. Kinnikinnick is always present, covering at least 20% of the ground on these dry slopes. An average of 25% of the ground surface is non-vegetated and consists of bare mineral soil and rocks. Grasses are usually dominant but vary in their composition. Bluebunch and slender wheatgrass are consistently present while pinegrass, junegrass or needlegrass species may also be quite abundant. Common juniper is usually scattered as are small shrubby aspen saplings. Nodding onion is often scattered while other herbs are sparse and vary from site to site and may include pussytoes, old man's whiskers, locoweed, showy Jacob's ladder and wild strawberry. This unit was mapped in all three mapping areas. It occurs as small patches on warm aspects adjacent to forested areas. The majority of these dry ecosystems remain undisturbed due to poor access.

Figure 3-2 Juniper/Kinnikinnick Submontane Grassland

Bluebunch Wheatgrass/Yarrow (IDFdk3/IDFxm)

This grassland ecosystem occurs on slightly cooler gentle northern or eastern slopes, often as the continuation of a grassland that occurs on the warmer side of the hill. Due to the cooler aspect, tree encroachment is common, suggesting that this grassland type is fire-dependent. Common plant species include bluebunch wheatgrass, arrow-leaved balsamroot, northern sweet-vetch, needle-and-thread grass, blue wildrye, Kentucky bluegrass, showy daisy, common sweetgrass, timber milk-vetch, dandelion, and field chickweed. Mosses and lichens are uncommon. This grassland was mapped in the transmission corridor and access road. This common grassland occurs as small localized

patches on south aspects and has been mapped in the both the transmission corridor and access road areas. Some of these grassland areas have been disturbed by cattle grazing.

Bluebunch Wheatgrass/Pasture Sage (BGxh3/BGxw2/IDFxm/IDFdk3, dk4)

This is a widespread, common grassland ecosystem that occurs on steep, eroded slopes, usually with a warm or hot aspect, on both sides of the Fraser River, often in gullies. Due to the steep slopes, soil surfaces are generally unstable and eroding, resulting in exposed soil. This ecosystem has many of the same plant species that occur in other units, but the abundance and composition of the vegetation varies depending on the degree of active surface erosion. The vegetation is typically dominated by widely spaced clumps of bluebunch wheatgrass and pasture sage. Other plant species include sand dropseed grass, needle-and-thread grass, pussytoes, junegrass and large-fruited desert-parsley. Total cover of mosses and lichens is low. This grassland was mapped in the transmission corridor and access road areas. While it is a common grassland type, patch size tends to be small, and localized to steep slopes with warm aspects. Most disturbances result from natural soil erosion processes.

Bluebunch Wheatgrass/Nodding Onion (BGxw2)

This grassland ecosystem occurs on moderately to steeply sloping north and northeast aspects close to the Fraser River, often occurs upslope of forested Douglas-fir stands. Bluebunch wheatgrass is the dominant forb, but a variety of other herbaceous species are also present. These sites typically lack needle-and-thread grass. The lichen community is well developed in the areas between grass bunches (60-75% cover) and is usually dominated by *Cladonia pyxidata, C. symphicarpa,* and *C. cariosa*. Species of *Psora* and *Collema* are sometimes present with low cover. Exposed mineral soil typically occupies less than 10% of these sites. This grassland is common, typically occurring as small patches within a forested matrix and was only mapped in the transmission corridor mapping area. The examples of this grassland that were sampled were relatively undisturbed.

Nuttall's Alkaligrass/Foxtail Barley (IDFdk3/IDFdk4)

These alkaline grassland ecosystems may have standing water during spring freshet, but become dry by mid-summer. The rich mineral soils have little organic accumulation and are strongly carbonated, but do not possess a solonetzic horizon. Salt crusts can be easy to spot when the soil surfaces become dry. This grassland has low species diversity and low total cover (usually less than 50%) due to high salinity. Nuttall's alkaligrass is usually present and other characteristic species include alkali saltgrass, foxtail barley, seablite, northern mannagrass, and Nevada bulrush. This ecosystem was been mapped in both the transmission corridor and access road areas. Due to the specialized soil conditions required, it only occurs as small patches adjacent to small wetlands. Livestock are attracted to these grasslands for watering and for use as mineral licks. As a result they are typically disturbed by extensive cattle trampling.

Dandelion/Timber Oat-grass (IDFdk4/SBPSxc)

These mesic to moist grassland ecosystems are dominated by dandelion and a variety of grasses including timber oatgrass, brome, and Wheeler's bluegrass. Yarrow and field chickweed are usually common. These sites occur along roads or adjacent to buildings

where cattle use is high. They occur as fairly small patches on flat or gently sloping areas. These grasslands were mapped in the transmission corridor and access road areas.

Baltic Rush/Field Sedge Meadow (IDFdk4/SBPSxc)

Also simply called "Field Sedge", these moist grassland ecosystems typically occur adjacent to wetlands in seasonally flooded and slightly alkaline depressions, and on slightly raised edges around ponds, marshes or fens. Patches of scrub birch shrub-carrs often occur between field sedge meadows and the forest edge. Field sedge (*Carex praegracilis*) is common on these sites as is Baltic rush, silverweed, tufted hairgrass and foxtail barley. Soils are fine textured. These ecosystems are blue-listed by the provincial CDC and are discussed in more detail in Appendix B.2 (Ecosystems of Conservation Concern). This grassland type occurs as small to medium sized patches surrounding wetlands or moist areas, and was only mapped in the access road area. Cattle grazing is common.

Figure 3-3 Baltic Rush–Field Sedge

Grass/Large-leaved Avens (IDFdk4/SBPSxc)

These moist grassland ecosystems are found in rich, silty soils along creeks in pockets of cold air drainage that discourage tree regeneration. Grasses include blue wild-rye, slender-stem wheatgrass, fringed brome, Kentucky bluegrass, and several others. Herbs include wild strawberry, fireweed, Sitka burnet, sheep sorrel, western dock, small-flowered penstemon, marsh valerian, dandelion, large-leaved avens, blue delphinium and western meadowrue. In wetter areas sedges may occur. Mineral soils are fine-textured

silty loam fluvial deposits with few coarse fragments. Drainage is imperfect to poor and soils are often gleyed. Some excellent examples of this grassland type have been mapped in the transmission corridor and access road mapping areas. They occur as pocket grasslands where soil, moisture regime, and microclimate are suitable. They receive some grazing from cattle, and do have some introduced plants but, due to rich soils and soil moisture, they rebound quickly from disturbance. They occur close to running water and are sensitive to changes in stream hydrology.

Figure 3-4 Grass/Large-leaved Avens Moist Grassland

Spreading Needlegrass/Baltic Rush (IDFdk4/IDFxm)

This grassland ecosystem occurs in broad depressions, toe slopes, and moisture receiving sites adjacent to wet meadows or wetlands. Parent materials are typically morainal in origin, but may be glaciofluvial or localized lacustrine deposits. Extensive grazing in places has resulted in an increase in cultivated and weedy plants such as Kentucky bluegrass and smooth brome. Less disturbed sites have a good cover of spreading needlegrass and Baltic rush. Other characteristic plant species include meadow salsify, slender wheatgrass, small-flowered penstemon, graceful cinquefoil and sweetgrass. Scattered low shrubs include prairie rose, saskatoon and snowberry. Cover of lichens is variable but ordinarily consists of a few *Cladonia* species and pelt lichens. Spreading needlegrass - Baltic rush was mapped in the transmission corridor and access road RSAs. This grassland is common, and patches can be up to several hectares in size. The most common disturbance is cattle grazing.

Figure 3-5 Spreading Needlegrass/Baltic Rush

Spreading Needlegrass/Pussytoes (IDFxm)

This grassland ecosystem was mapped in the transmission corridor where it often occurs as large contiguous patches. It is found on nearly level to gently sloping sites, not far from forest edges. Due to the windbreak effect and shading created by the forest, snow accumulation and duration of snow cover is generally greater than on drier site series. Vegetation of these sites is dominated by a nearly continuous cover of spreading needlegrass with abundant grass litter. Herbs such as small-flowered penstemon are scattered throughout the community, with cryptograms forming a crust between grass clumps. The lichen community is dominated by *Cladonia pyxidata* and *C. cariosa* but a wide variety of other *Cladonia* spp. and *Peltigera* spp. are also present. On some sites, short-awned porcupine grass is mixed with the spreading needlegrass. It was only mapped in the transmission corridor RSA. The patch size of this grassland type is typically large, with a wide distribution throughout the IDFxm subzone. Disturbance is incurred by grazing cattle and horses. In spite of grazing, many of these grasslands are healthy due to appropriate grazing levels and a lower risk of soil erosion.

Figure 3-6 Spreading Needlegrass/Pussytoes Grassland

Spreading Needlegrass/Sticky Purple Geranium (IDFxm)

This grassland ecosystem occurs in shallow depressions and swales within a matrix of drier grassland sites on the higher benches and upland areas close to the Fraser River (transmission corridor RSA). These sites are relatively moist in the spring due to late-lying snow and accumulation of snow meltwater. Late seral vegetation of this site series is dominated by a continuous cover of spreading needlegrass with some short-awned porcupinegrass and a wide variety of herbs. The vegetation is distinguished by the presence of sticky purple geranium. Lichens (mostly *Cladonia* spp. with some pelt lichens) and mosses (mostly *Brachythecium* sp.) cover areas between plants below the grass litter. This unit is common within the subzone, occurring as small patches within a matrix of larger grasslands such as IDFxm/Spreading needlegrass - pussytoes. Most of these areas are actively used for cattle grazing, but grasslands in the IDFxm are generally in relatively good condition.

Bluebunch Wheatgrass/Balsamroot (IDFdk4)

This grassland ecosystem occurs on gently to moderately sloping, mesic to submesic sites, primarily on south -and west-facing aspects from mid- to upper-slope positions. Parent materials are often aeolian veneers over morainal blankets or veneers. Undisturbed sites are dominated by bluebunch wheatgrass and a diverse array of grasses, forbs and lichens. Scattered, old Douglas-fir trees are common closer to forest edges. Dominant plant species include bluebunch wheatgrass, arrow-leaved balsamroot, northern sweet-vetch and *Cladonia cariosa*. Associate species can include needle-and-thread grass,

junegrass, pasture sage, spike-like goldenrod, showy daisy, meadow salsify, field chickweed, *Collema* spp. and rusty steppe moss. Bluebunch wheatgrass - Balsamroot was only mapped in the transmission corridor RSA, where it is usually found within a matrix of , or in proximity to, forested stands. Most of these grassland types that were sample were undisturbed or had light grazing.

4 Grassland Modelling

4.1 Objective

1. To organize and the 21 grassland types found in the project area into groups of varying sensitivity, based on the following:
    - provincial CDC listing (red, blue or unlisted);
    - susceptibility to invasive plants;
    - elevation (surrogate for average annual temperature);
    - predominant growth form (forb, grass or dwarf shrub); and
    - moisture (dry to wet).
2. To map and show the distribution of grasslands in the project area.

The ratings used are relative only to grasslands. For example, the rating for susceptibility to invasive plants pertains only to grasslands within the study area, and does not apply to other ecosystem types such as forests and wetlands.

4.1.1 Criteria Descriptions, Weighting and Assumptions Regarding Sensitivity

1. CDC rating

Red- and blue-listed ecosystems status is assigned by the BC CDC based on available literature and professional input by provincial biologists. The definitions of the listing status is provided below:

Table 4-1 Definitions of Rarity Ranks

BC Conservation Data Centre Conservation Rank Definitions	
S1	Critically Imperiled–Extremely rare throughout its range in the province (typically five or fewer occurrences or very few remaining individuals). May be especially vulnerable to extirpation
S2	Imperiled–Rare throughout its range in the province (20 or fewer occurrences or few remaining individuals). May be vulnerable to extirpation due to rarity or other factors
S3	Vulnerable–Vulnerable in the province due to a restricted range, relatively few populations (80 or fewer occurrences), recent and widespread declines, or other factors making it vulnerable to extirpation
S4	Apparently Secure–Uncommon but not rare throughout its range in the province, some cause for long-term concern due to declines or other factors (100 + occurrences)
S5	Secure–Common, widespread and abundant in the province
SU	Unrankable–Possibly in peril throughout its range in the province, but status uncertain; need more information. Used for new species not previously identified
SX	Presumed Extirpated–Species or community believed to be extirpated within the province

BC Conservation Data Centre Conservation Rank Definitions	
S#S#	Numeric range rank–A range between two consecutive numeric ranks. Denotes uncertainty about the exact rarity of the species (e.g., S1S2)
?	In exact or uncertain–For numeric ranks, denotes uncertainty, (e.g., SE?) denotes uncertainty of exotic status
Provincial List Status Definitions (BCCDC)	
Red-listed	Includes any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Red-listed taxa include those that have been, or are being evaluated for these designations
Blue-listed	Includes any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened
Yellow-listed	Includes any indigenous species or subspecies (taxa) which is not at risk in British Columbia

2. Elevation

Grassland ecosystems have been rated based on the elevation at which they typically occur. Elevation is used as a surrogate measure of average annual temperature. The ratings are:

A. low elevation biogeoclimatic units (BGxw2, BGxh3, IDFxm);

B. mid-elevation units (IDFdk3, IDFdk4, SBPSxc); and

C. high elevation units (MSxv and ESSFxv).

The assumption is that lower elevations are hotter, drier, more susceptible to soil erosion, and less likely to quickly recover from disturbance. Lower elevation grasslands have a higher potential for lichen crusts (biological soil crusts), which are often used as visible indicators of rangeland health. Many invasive plants are adapted to the warmer temperatures of lower elevations. On the other hand, higher elevation grasslands are assumed to be more robust due to greater moisture, less risk from soil erosion, and closer proximity to forested buffers.

3. Soil moisture (Dry or Moist)

The typical grasslands associated with open rangeland are seasonally dry, but many smaller grassland types are moist to periodically wet. In dry biogeoclimatic units, such grasslands are found on the perimeter of wetlands (e.g., Nuttall's alkaligrass - Foxtail barley, Alkali saltgrass - Nuttall's alkaligrass). At higher elevations, moist grasslands are found adjacent to wetlands and in riparian ecosystems. Dry grasslands are assumed to be more sensitive for the following reasons:

- Invasive plants can establish themselves on the exposed soil between plants.
- Lack of soil moisture can slow successional processes (i.e., vegetation communities are slow to rebound following disturbance).
- The open situation of dry grasslands favours disturbance by livestock and off-road vehicles.

4. Susceptibility/Sensitivity to Invasive plants

Higher elevation grasslands are smaller in size, often with natural forested buffers, so ingress of invasive plants is less likely than it is on extensive low elevation grasslands. Furthermore, many invasive plant species are adapted to warmer temperatures and are less likely to become established at higher elevations. Therefore, it is assumed that lower elevation grasslands have a higher susceptibility to invasive plants.

5. Dominant Growth form

Grassland ecosystems with a high cover of dwarf shrubs such as kinnikinnick and common juniper are considered to be less susceptible to invasive plants. The assumption is that the well-established woody root systems of dwarf shrubs reduce the chances of soil erosion and thereby provide fewer favourable sites for the germination of invasive plants.

4.1.2 Sensitivity Classes (Groups)

Group One–Highest Relative Sensitivity

This group has the highest relative sensitivity to project disturbance and consists exclusively of all red- and blue-listed grassland ecosystems mapped in the vegetation RSAs. Grasslands in this group all have a high potential for biological soil crusts, and high susceptibility to invasive plants, particularly if the mineral soil and soil crusts are disturbed. Notable grassland ecosystems in this group include the sagebrush steppe grasslands close to the Fraser River, as well as moist alkaline grasslands. This group also includes the blue-listed Baltic rush–Field sedge grassland that occurs in cooler subzones.

Group Two

Group two consists entirely of dry grassland ecosystems occurring in the warm, low elevation subzones that are not red or blue listed. This group is primarily comprised of bluebunch wheatgrass grassland ecosystems.

Group Three

This group consists of grassland ecosystems at middle elevations that include seasonally moist grassland types such as Spreading needlegrass - Baltic rush. It also includes the moist riparian Grass - Large-leaved avens grassland ecosystem.

Group Four–Lowest Relative Sensitivity

Group four has the lowest relative sensitivity to project disturbance. With one exception, this group consists of higher elevation grasslands. These grasslands are typically small and localized, and have an important component of dwarf shrubs such as kinnikinnick and common or Rocky Mountain juniper.

4.1.3 Grasslands as Valued Ecosystem Component

Grasslands are considered to be a Valued Ecosystem Component (VEC) in the Environmental Assessment for the Taseko project. The Key Indicator Resources (KIRs) of grasslands that were selected for focused investigation are:

- Vegetation loss from direct effects (e.g., roads, soil disturbance), and the indirect effects of project activities (e.g., loss of plant species due to displacement by introduced invasive species).

- Changes in abiotic conditions necessary for vegetation development as a result of direct effects (ground disturbance), and indirect effects due to changes in soil hydrology (e.g., changes in drainage patterns resulting from road cuts).
- Changes in the structure or composition of vegetation communities due to the direct effects of clearing and a variety of indirect effects from activities occurring in edge areas next to grasslands (e.g., roads or tower construction).

These three KIRs are the ecological components of grasslands that are most likely to be altered as a result of the project. The project activities that have the potential to result in a loss of grassland ecosystems are:

- access road construction and upgrades; and
- installation of the transmission power line (land clearing, road construction and tower construction).

Sensitivity to Project Disturbance

Introduced invasive plant and noxious weeds such as knapweed and cheatgrass have invaded many types of grassland in the Cariboo region (Iverson 2004). Direct or indirect damage to grasslands can occur through intensive livestock grazing, motorized recreational impacts, and agricultural and land development, range seeding, alien plant and animal introductions, predator control and hunting (Hooper and Pitt 1995). Fire suppression has resulted in forest encroachment onto grasslands, reducing the size of many grasslands in the Cariboo, particularly at higher elevations and on cooler, wetter sites (Cariboo-Chilcotin Grasslands Strategy Working Group 2001).

Grassland ecosystems are sensitive to project disturbance due to the potential for project related disturbances to create opportunities for establishment or dispersal of invasive plant species or ingress of woody species into grassland ecosystems

Effects Characterization

The magnitude, geographic extent, duration, frequency and reversibility of effects on grassland ecosystems are similar to those described for wetlands.

Magnitude

Low: Effect occurs that may or may not be measurable, but is within the range of natural variability (as a surrogate estimate this is set at <1% reduction in the availability of grassland ecosystems in the RSA).

Moderate: Effect occurs, but is unlikely to pose a serious risk to rare grassland ecosystems or present a management challenge (as a surrogate estimate this is set at 1-5% reduction in the availability of grassland ecosystems in the RSA).

High: Effect is likely to pose a serious risk to rare grassland ecosystems or present a management challenge (as a surrogate measure this is set at a >5% reduction in the availability of grassland ecosystems in the RSA).

4.1.4 Cumulative Effects

There is a potential for cumulative effects as a result of the ranching and forestry industries. In other words, the effects of the activities of one industry could be

exacerbated by the similar activities of another industry operating in the same area. Cumulative changes in plant structure and composition could occur due to:

- disturbance of soils and ground cover;
- overgrazing;
- alien seeds arriving via contaminated hay;
- use of grasslands as source for fill (e.g., for roads); and
- accidental fires (although, depending on the intensity, fires are sometimes good for grasslands).

4.1.5 Mitigation Approaches

One of the aims of construction projects will be to minimize any habitat loss directly (e.g. construction of a road across a grassland) or indirectly (e.g., discourage introduction of invasive plants which could spread into grasslands). Mitigation measures include steps to avoid negative effects before activities take place, to minimize effects during the project phases and, if necessary, to restore disturbed areas after construction.

Mitigation measures designed to avoid negative effects include:

- avoid work on or directly beside grasslands;
- minimize the size of construction footprints (roads and towers);
- create no-disturbance buffers around mapped grasslands;
- avoid disturbances near wetlands to protect grasslands that occur adjacent to fens, marshes and streams;
- promptly revegetate exposed soil;
- maintain natural hydrology;
- proper road and culvert installation;
- support and implement regional and agricultural initiatives to control invasive plant species and restore natural grasslands; and
- preventative measures during construction.

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