Appendix 16-A

Brucejack Gold Mine Project: 2012-2013 Terrestrial Ecosystem Baseline Studies

ERM

Pretium Resources Inc.

BRUCEJACK GOLD MINE PROJECT
2012-2013 Terrestrial Ecosystem Baseline Studies

PRETIVM

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BRUCEJACK GOLD MINE PROJECT

2012-2013 TERRESTRIAL ECOSYSTEM BASELINE STUDIES

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Executive Summary

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Executive Summary

The Brucejack Gold Mine Project (the Project) is situated within the Sulphurets District in the Iskut River region, approximately 20 kilometres northwest of Bowser Lake or 65 kilometres north-northwest of the town of Stewart, British Columbia. This report documents terrestrial ecosystems baseline studies completed for the Project area.

Terrestrial ecosystem baseline studies to support an environmental assessment application for the Brucejack Gold Mine Project (the Project) were undertaken in 2012 and completed in 2013. The goal of this study program was to characterize the ecosystems, vegetation, terrain and soils that could potentially be affected directly or indirectly by the Project, including those within the vicinity of the proposed Mine Site, the Transmission Line – South Option and existing exploration access road. Predictive Ecosystem mapping (PEM) and Terrestrial Ecosystem Mapping (TEM) were completed to characterize ecosystems within a Regional Study Area (RSA) and a Local Study Area (LSA), respectively. The mapping information is an integral component of the baseline program and provides useful information for resource management and project planning. The information collected during the baseline program will be used to carry out the effects assessments, develop management and mitigation plans, and guide the reclamation and closure plan.

The proposed Mine Site is situated above the treeline, and contains alpine ecosystems as well as an abundance of sparsely vegetated terrain. Much of the area around the proposed Mine Site contains disturbed soil and overburden material from past excavation and exploration activity. In undisturbed areas, soils derived from weathered bedrock and skeletal glacial till support alpine ecosystems, mostly Alpine Tundra Class and Alpine Heath Class. Ecosystems on colluvial slopes and other dry sites are limited to Alpine Fellfield Class and Alpine Nivation Class ecosystems. Some Subalpine Shrub group ecosystems are also present.

The exploration access road travels through old valley bottom forests dominated by subalpine fir and Engelmann spruce, and along dry glaciofluvial terraces supporting early seral pioneer ecosystems. Close to Highway 37, the exploration access road intersects with forests greater than 400 years old, dominated by zonal and wetter site series of the ICHvc subzone. These forests contain hybrid white spruce and subalpine fir, with an abundance of woody berry producing shrubs. Most of these ecosystems are developing on brunisolic and podzolic soils weathering from glacial till blankets and veneers over bedrock. As the road travels over the height of land, and skirting Todedada Wetland along upper Scott Creek, it traverses site series of the ESSFun and ESSFunp subzone. These ecosystems develop in very wet and very cold conditions, and experience snowpack into early summer. This is reflected in the open understory and shorter canopy heights than the ICHvc, and the prevalence of herb meadow ecosystems in sites fed by almost continuous snowmelt throughout the growing season. The proposed Transmission Line – East Option generally follows the exploration access road, thus crossing similar ecosystems.

The Transmission Line – South Option is situated in mature forest and recently deglaciated terrain, dominated by scoured rock, eroding moraine and glaciofluvial deposits. South of Granduc, forested zonal ecosystems of the MHmm1 and unclassified ecosystems of the MHmmp are common; at the farthest extension of the Transmission Line – South Option Sub-area, portions of the CWHwm subzone are present. In the lower elevations of the valley, along the Salmon River, the terrain is predominately composed of floodplain built up with coarse gravels and sands. Soils show little pedogenesis, typical of areas recently deglaciated. They include some Dystric Brunisols, but most are of the Regosol soil order.

Terrain north of the Salmon Glacier, along the Bowser River, is dominated by recently deposited glacial sediments. These sediments include glacial till veneers in upslope areas, medium and coarse textured morainal landforms, and glaciofluvial sediments. These glacial sediments are modified by post-glacial processes, such as mass wasting and surface erosion. Colluvium is common, with related landforms being talus slopes, colluvial fans and boulder fields.

Sensitive ecosystems, defined as those that are considered locally threatened, fragile or inherently sensitive to disturbance. Sensitive ecosystems assessed in this chapter as valued components include CDC (listed) ecosystems, riparian and floodplain ecosystems, alpine and parkland ecosystems, old forest ecosystems, and herbaceous meadow ecosystems. Wetland ecosystems are assessed separately in the wetlands baseline report (Rescan 2013b).

Five sensitive ecosystems types, those that are considered locally threatened, fragile or inherently sensitive to disturbance defined were observed within the LSA and/ or RSA, including 12 CDC (listed) ecosystems, 12 riparian and floodplain ecosystems, 6 alpine and 10 parkland ecosystems as well as 4,239 ha of old forest ecosystems, and 93 ha of herbaceous meadow ecosystems within the LSA.

Rare plant and lichen surveys were conducted in 2012 and 2013 to determine the presence of species that have a conservation-priority S-ranking (subnational (i.e., provincial) conservation ranking; protection under the Species at Risk Act (SARA), those ranked as threatened or endangered by COSEWIC or otherwise considered rare within the LSA and at select sites within the surrounding area.

Seventy-six rare plant and lichen species were identified within the LSA, consisting of 19 vascular plant, 42 lichen and 15 moss species. None of the rare species found are currently listed under SARA or by COSEWIC; however, one species is on the candidate list for the SARA. Fifty nine of the species are listed by the BC CDC and 17 are considered rare but previously undocumented in British Columbia, new to science or ranked as SU (i.e., uncertain by the BC CDC).

Two invasive plants, common tansy (*Tanacetum vulgare*) and oxeye daisy (*Leucanthemum vulgare*) were identified along the east side of Highway 37. These species are classified as noxious under the Weed Control Act and extremely invasive to very invasive by the Northwest Invasive Plant Council.

As part of the baseline studies, soil, lichens, berries, and plant tissue samples were collected to establish baseline metal concentrations. The metals analyses is used to estimate baseline metal levels in the area of proposed infrastructure as well as control sites outside of the expected zone of influence of Project environmental effects. This data comprises the basis to evaluate any changes in metal levels due to the Project. Samples collected and analyzed included soil, lichen and plant tissue samples. Results from the baseline metals analysis may be used for country foods assessments and/or future monitoring programs.

Fifty soil samples from 34 soil inspection sites were obtained from across the LSA. These samples were analyzed for a suite of 31 metals, of which 19 have CCME Industrial Use Guideline criteria values. Seven of the nineteen metals were noted to exceed industrial use criteria at least once. Arsenic was the most frequently occurring metal of concern, as 31 of 50 samples tested exceed the industrial guideline concentration.

Two species of lichen were collected: black footed reindeer lichen (*Cladina stygia*) and eyed foam lichen (*Stereocaulon tomentosum*). A total of 22 lichen samples were analyzed for a suite of 39 metals. Notably, three of these samples, all within the Mine Site, contained higher concentration of arsenic than rest of the samples. These sites also correspond to sites with elevated arsenic in the soils.

A total of 31 berry samples were collected. Five species were targeted for sampling including oval leaf blueberry (*Vaccinium ovalifolium*), black huckleberry (*Vaccinium membranaceum*), bog blueberry (*Vaccinium uliginosum*), highbush cranberry (*Viburnum edule)* and soapberry (*Shepherdia canadensis*). Thirty water sedge (*Carex aquatilis*) samples from ten sites within the Access Road Sub-area were also collected.

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BRUCEJACK GOLD MINE PROJECT
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Glossary and Abbreviations

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Alpine — High-elevation land above the tree-line. Alpine vegetation on zonal sites is dominated by low shrubs, herbs, bryophytes and lichens. Although treeless by definition, patches of stunted (krummholz) trees may occur. Much of the alpine is covered by rock and ice rather than vegetation.

BC CDC — British Columbia Conservation Data Centre — Collects and disseminates information on plants, animals and ecosystems (ecological communities) at risk at the provincial level, and is tied to NatureServe, an international, non-profit organization of cooperating Conservation Data Centres and Natural Heritage Programs all using the same methodology to gather and exchange information on the threatened elements of biodiversity.

BEC — Biogeoclimatic Ecosystem Classification — A standard, hierarchical classification system that is used as basis for terrestrial ecosystem mapping in British Columbia.

Biogeoclimatic subzone — A level of the biogeoclimatic classification system that defines the climate of an area, as characterized by the plant association occurring on zonal sites (e.g., Mountain Hemlock moist maritime, MHmm; (BC Ministry of Forests and Range 2007).

Biogeoclimatic units — A general term referring to any level of Biogeoclimatic zones, subzones, variants or phases. Biogeoclimatic units are inferred from a system of ecological classification based on a floristic hierarchy of plant associations. The recognized units are a synthesis of climate, vegetation, and soil data (Pojar, Klinka, and Meidinger 1987).

Biogeoclimatic variant — A further subdivision of biogeoclimatic subzone reflecting further differences in regional climate. Variants are described as warmer, colder, drier, wetter, or snowier than the "typical" subzone (e.g., Mountain Hemlock moist maritime leeward variant (MHmm2).

Biogeoclimatic zone — Geographical areas having similar patterns of energy flow, vegetation and soils as a result of a broadly homogeneous macroclimate. Biogeoclimatic zones are comprised of biogeoclimatic subzones with similar zonal climax ecosystems (BC Ministry of Forests and Range 2007).

Blue-list — A list of ecological communities, and indigenous species and subspecies of special concern in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at risk, but are not Extirpated, Endangered or Threatened (BC MOE 2007).

Chronosequence — With respect to ecosystems, the communities predictably develop and decline over time.

Climax ecosystem — The final and relatively stable stage in plant succession for a given environment where the species present perpetuate themselves in the absence of disturbance.

COSEWIC	Committee on the Status of Endangered Wildlife in Canada — A federal committee of experts that assesses and designates the level of threat to wildlife and vegetation species in Canada.
Disclimax	An ecosystem that reaches steady state due to reasons other than local climate and edaphic conditions. Such ecosystems include avalanche tracks and floodplains, which are maintained by consistent disturbance.
Ecosystem (terrestrial)	A volume of earth-space that is composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred.
Edaphic	Pertaining to soils, site specific variation in moisture, nutrients, and climate that result in specific ecological attributes as expressed in vegetation.
Forb	Non-grassy herbaceous plant.
Herb	A plant, either annual, biennial or perennial, with stems that die back to the ground at the end of the growing season. Herbaceous species include forbs, graminoids (sedge, grasses, and rushes), ferns, and fern allies (e.g., horsetails).
Invasive Plant	Any alien plant species that has the potential to pose undesirable or detrimental impacts on humans, animals or ecosystems.
Land Cover	The physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures (Ellis and Pontius 2007).
Moisture regime	Indicates, on a relative scale, the available moisture for plant growth in terms of the soil's ability to hold, lose, or receive water. Described as moisture classes from Very Xeric (0) to Hydric (8; (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).
Nutrient regime	Indicates the available nutrient supply for plant growth on a site, relative to the supply on all surrounding sites. Nutrient regime is based on a number of environmental and biotic factors, and is described as classes from very poor (A) to very rich (E) and saline (F; (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).
Parkland	Subalpine area characterized by forest clumps interspersed with open subalpine meadows and shrub thickets. Vegetation cover may vary in the proportion of treed patches, meadows, and shrub thickets.
Polygon	Delineations that represent discrete areas on a map, bounded by a line. On an ecosystem map, polygons depicting ecosystem map units are nested within larger polygons containing the biogeoclimatic and ecoregion map units. Polygons depicting ecosystem units represent areas from less than one hectare to several hundred hectares, depending on the scale of mapping.
Red-list	List of ecological communities, and indigenous species and subspecies that are extirpated, endangered or threatened in British Columbia. Red listed species and sub-species have — or are candidates for — official Extirpated, Endangered or Threatened Status in B.C. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

SARA — *Species at Risk Act* (2002) — Canadian federal legislation which is designed to meet one of Canada's key commitments under the International Convention on Biological Diversity. The goal of the Act is to protect endangered or threatened organisms and their habitats. It also manages species which are not yet threatened, but whose existence or habitat is in jeopardy.

Seral — A transitional vegetation community, the properties of which promote the establishment of another vegetation community.

Site series — Describes all land areas capable of producing the same late seral or climax plant community within a biogeoclimatic subzone or variant (Banner et al. 1993). Site series are usually related to a specified range of soil moisture and nutrient regimes within a subzone or variant, but other factors, such as aspect or disturbance history may influence it as well. Site series form the basis of ecosystem units (definition taken directly from the TEM standards, RIC 1998).

Structural Stage — Describes the structural characteristics, and often the age, of vegetated ecosystems (RIC 1998).

TEM — Terrestrial Ecosystem Mapping — Delineation and attribution of ecosystem units based on air photo interpretation. Mapping follows provincial standards and a pre-defined classification system.

1. Introduction

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1. Introduction

Terrestrial ecosystem baseline studies to support an environmental assessment application for the Brucejack Gold Mine Project (the Project) were undertaken in 2012. These studies involved assessing the terrain, soils, vegetation and ecosystems present within a local and regional study area. These studies are required under the *Mines Act*, as well as other legislation. This report presents the background ecology and terrain of the area, the legislative requirements for baseline studies, methods and results. In 1989, Newhawk Gold Mines Ltd. submitted an Environmental and Socioeconomic Impact Assessment for the Sulphurets property, which included the Brucejack Lake area. This assessment included an overview of the ecosystems, terrain, and soils present in the area.

The goal of this study program is to characterize the ecosystems, vegetation, terrain and soils that could potentially be affected directly or indirectly by the Project, including those within the vicinity of the proposed Mine Site, the Transmission Line – South Option and existing exploration access road. Predictive Ecosystem mapping and Terrestrial Ecosystem Mapping (TEM) were completed to characterize ecosystems within a Regional Study Area and a Local Study Area, respectively. The mapping information an integral component of the baseline program and provides useful information for resource management and Project planning. The information collected during the baseline program will be used to carry out the effects assessments, develop management and mitigation plans, and guide the reclamation and closure plan.

2. Project Description

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2. Project Description

Pretium Resources Inc. (Pretivm) proposes to develop the Project as a 2,700 tonne per day (tpd) underground gold and silver mine. The Brucejack Property is located at 56°28′20″ N latitude by 130°11′31″ W longitude, which is approximately 950 km northwest of Vancouver, 65 km north-northwest of Stewart, and 21 km south-southeast of the closed Eskay Creek Mine (Figure 2-1). The Project is located within the Kitimat-Stikine Regional District. Several First Nation and Treaty Nations have traditional territory within the general region of the Project including the Skii km Lax Ha, the Nisga'a Nation, the Tahltan Nation, the Gitxsan Nation, and the Gitanyow First Nation.

The Mine Site area will be located near Brucejack Lake. Vehicle access to the Mine Site will be via an existing exploration access road from Highway 37 that may require upgrades to facilitate traffic during mine operations. A transmission line will connect the Mine Site to the provincial power grid near Stewart or along Highway 37; two options are currently under consideration.

The Project is located within the boundary range of the Coast Mountain Physiographic Belt, along the western margin of the Intermontane Tectonic Belt. The local terrain ranges from generally steep in the western portion of the Project area in the high alpine with substantial glacier cover to relatively subdued topography in the eastern portion of the Project area towards the Bell-Irving River. The Brucejack Mine Site will be located above the tree line in a mountainous area at an elevation of approximately 1,400 masl; surrounding peaks measure 2,200 m in elevation. The access and transmission corridors will span a range of elevations and ecosystems reaching a minimum elevation near the Bell Irving River of 500 masl.

The general area of the Brucejack Property has been the target of mineral exploration since the 1960s. In the 1980s Newhawk Gold Mines Ltd. conducted advanced exploration activities at the current site of the proposed Brucejack Mine Site that included five km of underground development, construction of an access road along the Bowser River and Knipple Glacier, and resulted in the deposition of 60,000 m^3 of waste rock within Brucejack Lake.

Environmental baseline data was collected from Brucejack Lake and the surrounding vicinity in the 1980s to support a Stage I Impact Assessment for the Sulphurets Project proposed by Newhawk Gold Mines Ltd. Silver Standard Resources Inc. commenced recent environmental baseline studies specific to the currently proposed Project in 2009 which have been continued by Pretivm, following its acquisition of the Project in 2010. The scope and scale of the recent environmental baseline programs have varied over the period from 2009 to the present as the development plan for the Project has evolved.

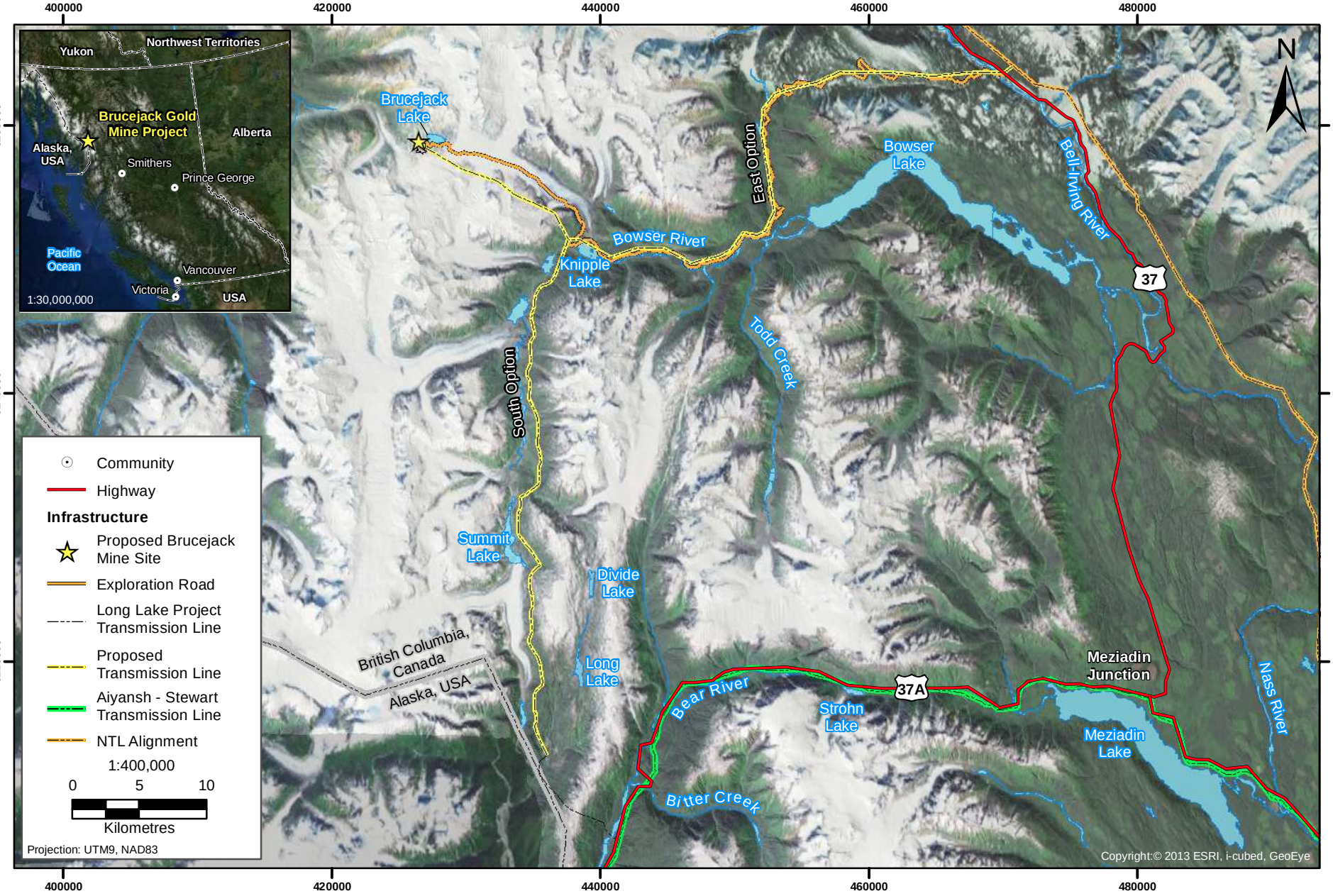

Figure 2-1

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Brucejack Gold Mine Project Overview

Figure 2-1

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3. Background Information

3. Background Information

3.1 REGIONAL SETTING

The Project is situated within the Skeena Mountains Ecoregion, the Boundary Ranges Ecoregion, and the Nass Ranges Ecoregion. Towards the coast, the Boundary Ranges consist of extensive ice fields capping granitic intrusions remnant of the Coast Range Arc, and are dissected by several major river valleys, including the Nass River. Inland and east of the Boundary Ranges lays the Skeena Mountains Ecoregion, which consists of high rugged mountains and a moist, coast/interior transition climate, supporting many glaciers. The Nass Ranges Ecoregion, with a climate somewhat transitional between coastal and interior regimes (Demarchi 1996), is a mountainous area west of the Kitimat Ranges (south of the Project).

3.1.1 Ecoregional Classification

Ecosection descriptions provide a general description of the physiographic and climatic influences within an area. Three ecosections are present in the immediate area: two from within the Nass Ranges Ecoregion - Meziadin Mountains and Nass Basin Ecosections, and one from within the Boundary Ranges Ecoregion - Southern Boundary Ranges Ecosection.

The Project is predominantly within the Meziadin Mountains Ecosection (Figures 3.1-1 and 3.1-2). This area is rugged and mountainous, lying on the leeward side of the main Boundary Ranges and west of the low Nass Basin. The mountains are predominantly underlain by volcanic and sedimentary (and small granitic batholiths) rock. Ice that formed in the Boundary Ranges during the last years of the Pleistocene Epoch moved east into the Nass Basin, coalescing with ice moving south from the adjacent Skeena Mountains which then moved down and out the Nass Valley, through the adjoining Nass Basin Ecosection. The mountain summits still have small icefields and glaciers. The area of the proposed Project within this ecosection is drained by the upper Bowser River and many small streams that empty into the Nass River.

There is a strong rainshadow effect here, as the western summits protect this area from Pacific air that arrives from over the Boundary Ranges to the west. Some Pacific air can enter into this area via the wide Nass River valley, bringing heavy rain and dense cloud cover. In the winter and early spring, cold Arctic air can override the Skeena Mountains to the west and build up along the east side of this ecosection, bringing short periods of intense cold, which, when encountering warm Pacific air, can lead to heavy snowfalls. The southern east-facing valleys have wet Coastal Western Hemlock (CWH) forests, with wet Mountain Hemlock (MH) subalpine forests on the upper slopes. The northern portion of this ecosection has cold Interior Cedar – Hemlock (ICH) forests in the east-facing valleys, with cold Engelmann Spruce – Subalpine Fir (ESSF) forest on the mid-to-upper slopes. Alpine can be heavily vegetated or barren rock.

Close to Highway 37, the exploration access road crosses through the Nass Basin Ecosection. This ecosection is described locally as a basin of low relief that is encircled by sharply rising mountains, the Boundary Ranges (and Meziadin Mountains Ecosection) to the west, and the Skeena Mountains on the east. Bedrock underlying this basin is predominantly volcanic, though locally, within the LSA, sedimentary, and the relief is flat or gently rolling. Glaciers that formed in the Boundary Ranges and Skeena Mountains during the most recent glaciation flowed down, out over these flat lands, and south, down the Nass River. There are many meandering streams, wetlands and small lakes. This ecosection is drained primarily by the Bell-Irving River that flows to the lower Nass River.

The climate is intermediate between the cool, wet conditions of the outer coast and the drier, conditions of the interior. The cold, Arctic air that invades this basin allows a more interior forest type, the Interior Cedar – Hemlock (ICH) forests to grow on the valley floor. Subalpine forests of Engelmann Spruce - Subalpine Fir (ESSF) occur on the few higher hills and ridges.

The western margin of the exploration access road and the southern half of the Transmission Line-South Option, cross into the Southern Boundary Ranges Ecosection from the Meziadin Mountains Ecosection area. This is an area of wet rugged mountains that are capped with glaciers, small icefields and exposed granitic and metamorphic bedrock. This area was heavily impacted by large sheets of ice that originated along the crest of the mountains, during the most recent glaciation and into the early years of the Holocene Epoch. Many large remnant icefields and glaciers remain on the summits. The Unuk River dissects these mountains, and several smaller ones, such as the upper Bowser River, Salmon River and Bear River, which drain directly into marine channels or sounds.

Moist Pacific air moves over this ecosection bringing intense precipitation to the windward slopes and adjacent mountains in the northern interior of British Columbia. At the same time it also allows cold Arctic air to pass onto the north coast of B.C. Forests are either very wet, such as Coastal Western Hemlock (CWH), or cold and wet such as the subalpine Mountain Hemlock (MH) forests that occur on all the middle elevation slopes. Alpine areas are extensive, and are dominated by heath heather, alpine herb meadows, exposed bedrock, and ice.

Surrounding the Project area, extensive recently deglaciated and still glaciated areas are common. Parkland ecosystems occupy a narrow elevation band above dense coniferous forests and below the treeless alpine ecosystems. These ecosystems are characterized by discontinuous tree islands growing on elevated sites, which experience early snowmelt and drainage of excessive moisture that prohibits forest establishment at higher elevations. Avalanches are very common due to the steep topography and abundant snowfall. Avalanche track ecosystems develop in areas with frequent avalanches; the herbaceous vegetation that grows within many of these tracks provides valuable forage for several wildlife species, including grizzly and black bears. Mass wasting events such as landslides and debris flows occur regularly, many occurring in the over-steepened lateral moraines deposited during recent and ongoing deglaciation.

Below approximately 1,100 m, forested ecosystems dominate the landscape. In the general area of the Project, they are fairly continuous, interrupted by natural disturbances including those already described (avalanches, mass wasting), as well as fluvial disturbances such as flooding, channel aggradation and degradation, and debris flows. Subalpine fir and hybrid white spruce are the dominant tree species on mesic and wetter sites, while single species stands of mountain hemlock occupy some rocky and dry sites. Western hemlock is common in the south and west of the Project, especially along the Transmission Line – South Option, and becomes less common to the east and north. Many of the forests in the lower slopes and valley bottoms are very old, at least 500 years in some areas. This is due to the rarity of stand replacement disturbance events, such as wildfire (BC MOF 1995). In addition, there has been little in the way of forest harvesting, and that which has occurred is confined to the immediate area surrounding Highway 37. The diverse structures of these old growth forests provide a mosaic of habitats within close proximity to each other and retain an abundant biodiversity not associated with younger, less complex ecosystems. High value habitat includes that for marten, fisher and a diversity of forest bird species. Higher elevation forests provide forage and cover to moose and mountain goats as well as berries and herbaceous plants for bears. Early seral vegetation provides winter habitat for moose and spring forage to grizzly and black bears. During the summer and fall months, berries are an important food resource to humans and bears.

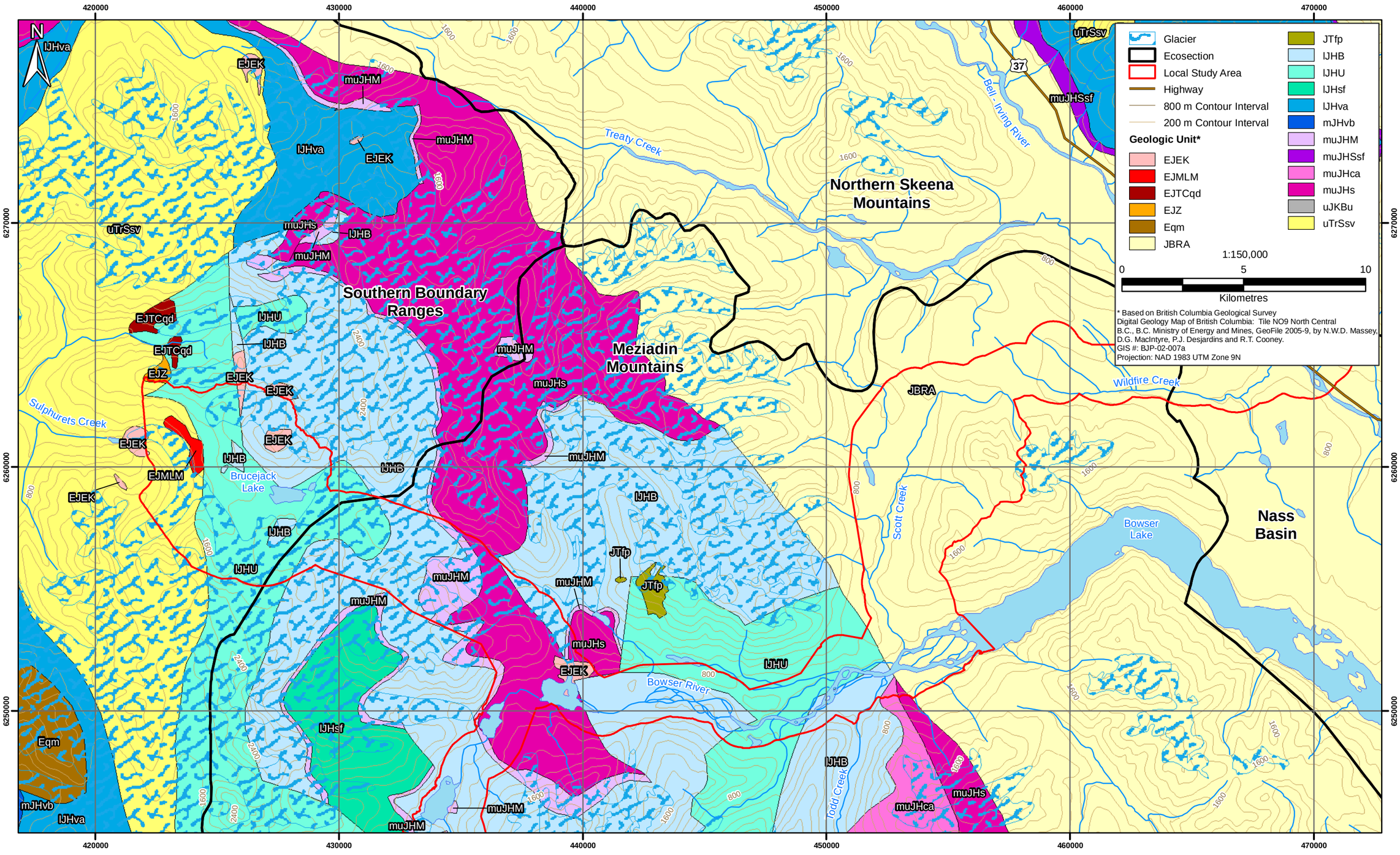

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Figure 3.1-1

Regional Geology of the Project Area - Northern Area

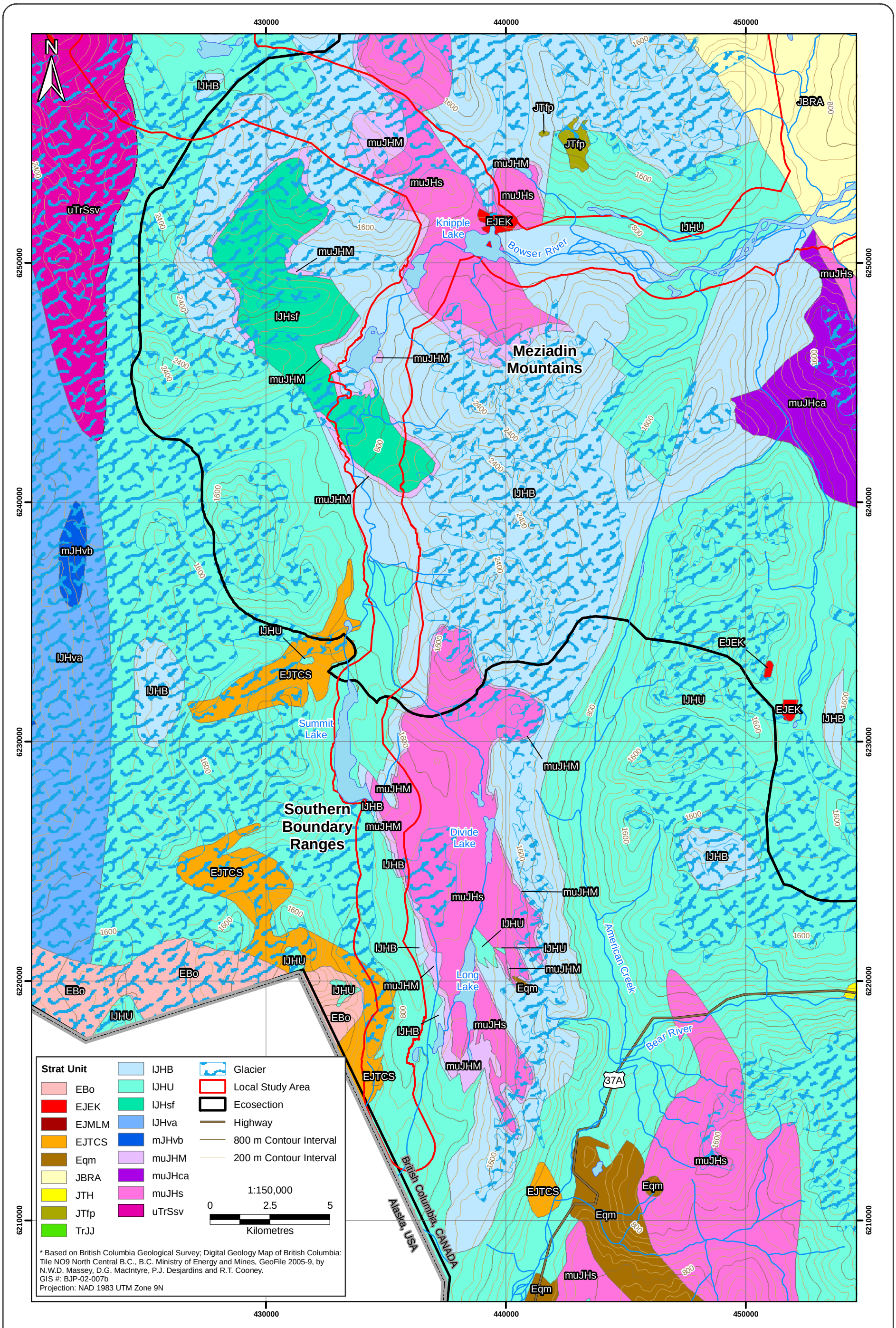

Figure 3.1-2

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Regional Geology of the Project Area, Southern Area

Figure 3.1-2

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Ecosystems that develop along watercourses, both active and inactive, have unique attributes that provide specific values for wildlife, soil retention, and hydrological buffering. Forested ecosystems developing on aggraded fluvial deposits are very common in the terrestrial ecosystem study areas, and are found along Wildfire Creek, the Salmon River, and the Bowser River. Some ecosystems develop on landforms that are no longer inundated by annual flood events, but experience extensive subterranean irrigation. Cottonwood trees, a preferred nesting tree for raptors, such as bald eagles, thrive in these conditions. The resulting forest is often composed of large mature cottonwood with an understory of either subalpine fir or hybrid white spruce. Active floodplain ecosystems are subject to regular disturbance, which promotes the longevity of pioneer species, such as willow and alder, as well as herbaceous species such as lady fern, which grows in response to the high nutrient load provided by flood events and decomposition of pioneer species leaf litter. This vegetation provides forage for wildlife species that use floodplain riparian ecosystems as movement corridors. The vigorous vegetation growth also helps to retain soils that would otherwise be transported by flood events. The complex channel morphology allows for the development of backwater channel swamp and fen ecosystems. These are capable of storing large volumes of water, which mitigate flows during high water events, reducing the energy of floods downstream.

3.1.2 Geology of the Project Area

The interaction of local geology with geomorphic processes over time greatly determines how ecosystems develop. The BC Geologic Survey regional bedrock mapping is summarized as follows by Groups/ Formations (stratigraphic unit abbreviations) and rock types. The Bowser Lake Group is mapped along the eastern half of the exploration access road. It includes the Middle to Upper Jurassic Bowser Lake Group Ritchie-Alger Assemblage (JBRA) of sedimentary, sandstone, siltstone and rare conglomerate.

The Hazelton Group is mapped in most other areas around the Project, except for the extreme western edge, which is mapped as the Stuhini group and includes the Mine Site. The Hazelton Group has many formations, including the following:

- Unuk River (lJHU) — andesitic volcanic rocks;
- Betty Creek (lJHB) — volcaniclastic rocks;
- Mount Dilworth (muJHM) — calc-alkaline volcanic rocks;
- (muJHca) — calc-alkaline volcanic rocks;
- (muJHs) undivided sedimentary;
- (lJHsf) mudstone, siltstone, shale, fine clastic sedimentary rocks; and
- Eskay Porphyry, Knipple Porphyry or Inel Stock (EJEK) — feldspar porphyritic intrusive rocks.

3.2 APPLICABLE LEGISLATION (FEDERAL AND PROVINCIAL)

3.2.1 Legislation and Best Management Practices for Terrestrial Ecosystems and Vegetation

Legislation, organizations, guidelines, and best management practices applicable to the management of terrestrial ecosystems and vegetation for mine developments are listed and described below:

- *(BC) Mines Act* (1996a);
- *(BC) Forest and Range Practices Act* (2002a);
- *(Canada) Species at Risk Act* (*SARA*; 2002b);

- *(BC) Conservation Data Centre* (BC MOE 2007b);
- *(Canada) Canadian Biodiversity Strategy* (Federal-Provincial-Territorial Biodiversity Working Group 1995);
- *(BC) Weed Control Act* (1996c);
- (BC) *North West Invasive Plant Council* (NWIPC 2012);
- *(BC) Wildlife Act* (1996d);
- *(BC) Environmental Management Act* (2003);
- *(Canada) Fisheries Act* (1985);
- *(BC) Fish Protection Act* (1997); and
- The *Mines Act* (1996) *Health, Safety and Reclamation Code*

3.2.1.1 Mines Act

The BC Ministry of Energy, Mines, and Natural Gas (BC MEMNG) requires that Terrestrial Ecosystem Mapping (TEM) of a proposed Mine Site be completed for all mining permit applications. A Local Study Area (LSA) encompassing the Mine Site can be defined by natural features (i.e., watershed boundaries) or by buffers surrounding the proposed infrastructure. To enable the assessments of effects within a regional study area (RSA) or to enable ecosystem distribution comparisons over large areas, Predictive Ecosystem Mapping is typically conducted within an RSA. The RSA boundary contains the LSA and may be delineated by natural boundaries, such as river drainage basins or other landscape features, or by other criteria such as habitat required or used by key wildlife species.

The BC MEMNG requires characterization of baseline metal concentrations in plant tissues. This information is used to assess changes over time and to guide reclamation planning (BC MEM 1998).

3.2.1.2 Forest and Range Practices Act

The *Forest and Range Practices Act* (2002a) governs all forestry activities including logging, road building, reforestation and riparian area management. The act requires that all forestry-related development be conducted in accordance with the rules and regulations identified in the act to ensure the protection of environmental values. The *Forest and Range Practices Act* (2002a) addresses ecosystems as wildlife habitat through the Identified Wildlife Management Strategy.

3.2.1.3 Species at Risk Act

The purpose of SARA (2002b) is to prevent species at risk from becoming extirpated or extinct and ensure the appropriate management of species to prevent them from becoming at risk. Certain species are also protected under SARA as part of wildlife habitat and in accordance with the Canadian Biodiversity Strategy. The Canadian Biodiversity Strategy provides federal legislation that supports the conservation of particular species and populations to ensure continuance of biological diversity over time (Federal-Provincial-Territorial Biodiversity Working Group 1995).

3.2.1.4 BC Conservation Data Centre

The BC CDC (BC MOE 2007b), a part of the Environmental Stewardship Division in the BC MOE, classifies plant species and ecosystems at risk in the province as either red-listed (extirpated, endangered, or threatened) or blue-listed (of special concern), and tracks information regarding their conservation status and individual locations. Best management practices and guidelines for land developments recommend that red and blue-listed plants and ecosystems be protected (BC MOE 2006).

3.2.1.5 Canadian Biodiversity Strategy

The Canadian Biodiversity Strategy, released in 1995, states that governments in Canada must create the policy and research conditions that will lead to the conservation of biodiversity and sustainable use of biological resources. By 1996, all Canadian jurisdictions had signed a statement of commitment to use the Strategy as a guide to implementing the Convention in Canada (Biodivcanada.ca 2012).

3.2.1.6 BC Weed Control Act

The *Weed Control Act* (1985) regulates the management of noxious plants in BC. The act requires all land occupiers to avoid establishment and dispersal of noxious weeds as defined by the act.

3.2.1.7 North West Invasive Plant Council

The Northwest Invasive Plant Council of BC (NWIPC) developed as a committee in 1992 and a not-for-profit organization in 2004 following a request by the inter-ministerial Invasive Plant Committee to pilot a single agency regional delivery model for invasive plant programs. The NWIPC provides support and coordination advice to those involved in invasive plant management and has a stated goal of "preventing further damage to the ecosystems of the northwest and central BC from invasive alien plants" (NWIPC 2012). With a Board of Directors representing a range of stakeholder groups, the NWIPC currently has directors that represent local government, the provincial government, *Aboriginal peoples*, agriculture industries, utilities and environmental groups. The NWIPC is governed by bylaws and a constitution and provides strategy documents for managing invasive species. A current list of the *Most Unwanted Weeds* in the region is maintained on the NWIPC website.

3.2.1.8 BC Wildlife Act

The provincial *Wildlife Act* (1996d) provides for conservation of specific ecosystems and ecosystem components as they provide habitat for species managed by the BC MOE.

3.2.1.9 Environmental Management Act

Pulling together the provisions of the previous Waste Management and Environment Management Acts into a single statute, the *Environmental Management Act* (2003) prohibits the introduction of deleterious substances into the environment in any manner or quantity that may cause pollution to the environment as defined in the *act*. This includes substances that would degrade or contaminate soil and water, which could in turn have deleterious effects on terrestrial ecosystems.

3.2.1.10 Federal Fisheries Act

The *Fisheries Act* (1985) provides the legal framework to protect fish habitat from flooding and potential loss of land due to stream erosion and instability. Section 35 establishes rules guiding development within the Fisheries Sensitive Zones and watercourses. Section 36 establishes rules for erosion control related to land development activities, such as clearing land, grading slopes, and road construction and maintenance.

3.2.1.11 Fish Protection Act

The *Fish Protection Act* (1997) and associated amendments to the provincial *Water Act* (1996b) regulate provincial approvals of alterations and work in and around watercourses. The regulations focus on riparian retention, which may be involved in vegetation removal and introduction of harmful debris (clay, silt, sand, rock, or any material, natural or otherwise) into the waterways.

3.2.1.12 The Mines Act *(1996) Health, Safety and Reclamation Code for Mines in British Columbia*

The Code requires that the environmental protection of land and water resources, as well as the reclamation of disturbed land, be planned in advance and that plans follow standards outlined by the Code (BC MEMPR 2008). The Code specifies standards that must be achieved during mining activities and requires regular site inspections and annual reporting (Reclamation and Closure, Part 10) to ensure compliance.

3.2.2 Legislation and Best Management Practices for Terrain and Soils

Under the *Mines Act* (1996), the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEMPR 2008) require proponents to provide:

- information on surficial geology, terrain mapping, soils , vegetation, wildlife, and present land use;
- a Soil Salvage and Handling Plan;
- an Erosion Control Plan; and
- a Closure and Reclamation Plan.

Relevant information requirements set under the Fish Habitat Protection and Pollution Prevention provisions of the *Fisheries Act* (1985) include descriptions of measures that will be taken to avoid or minimize any impacts on the aquatic environment, during Project development or its subsequent operation (Section 37). The *Fisheries Act* (1985) also regulates the discharge of harmful substances into the fish habitat (Section 34) and imposes reporting requirements in case an impact on fish habitat occurs (Section 38). Consideration of the above legislation is particularly important in cases when Project development takes place near shorelines or riparian areas. Potential impacts include migration of chemical contaminants and sediment into the aquatic environment.

Watercourse sedimentation typically results from soil erosion, and, while prevention of both processes is the focus of various best management practices (BMPs), currently it is not regulated by law. However, since unpaved roads have potential to contribute significantly to soil erosion, in British Columbia (BC) road construction within forested areas is governed by the *Forest and Range Practices Act* (2002). The Act requires that road construction adheres to codes provided in the Forest Service Road Use Regulation (BC Reg. 70/2004), which focuses extensively on erosion prevention.

Matters related to contamination of the terrestrial habitat are regulated by the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2012). These guidelines provide Canada-wide standards for the maximum limits of various toxic substances (e.g., metals, hydrocarbons, pesticides, etc.) in the soil. Similarly, the Contaminated Sites Regulation (BC Reg. 375/96) included in BC's *Environmental Management Act* (2003) lists Soil Criteria for Toxicity to Soil Invertebrates and Plants. These provide numerical standards to define whether a site is contaminated, to determine liability for site remediation, and to assess reclamation success.

4. Objectives

4. Objectives

The main objectives of the terrestrial ecosystems baseline studies program are as follows:

- map and characterize the terrain, surficial materials, and soils in a local study area (LSA);
- map and characterize ecosystems in the LSA, including sensitive and rare ecosystems;
- map and characterize ecosystems in a regional study area (RSA);
- identify soil characteristics that may be sensitive to disturbances and features that could potentially affect the construction, operation, and decommissioning of the Project facilities;
- identify plant species present in the LSA, including invasive plant species, and those species tracked by the BC CDC, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and protected under the *Species At Risk Act* (SARA) or otherwise considered rare or of conservation interest;
- provide sufficient information to develop the effects assessment, management and mitigation plans, and the reclamation and closure plan; and
- determine soil and vegetation baseline metal concentrations.

5. Study Area

5. Study Area

Ecosystems and vegetation were characterized for two study areas, a LSA and a RSA (Figure 5-1). The LSA is 31,847 ha in size and is defined by a buffer extending at least to the height of land or 1.0 km buffer around the outer limits of the proposed infrastructure and linear developments. Watershed height-of-land borders were often used to define study areas, as they are physical barriers to transference of many project related effects. Buffers are used to account for the potential effects that could migrate beyond the project footprint, such as those related to hydrologic change and dust. In certain areas other physical features were also used to define the LSA, when they were considered likely to be the limit of the potential effects of the Project. For example, along the Transmission Line – South Option, the western bank of the Salmon River forms much of the western LSA boundary, as downstream effects of upstream construction, such as erosion and sedimentation, are unlikely to impact beyond this physical barrier.

The LSA was divided into three separate sub-areas for the purposes of this report because of the variety of landforms and vegetation types present in the LSA, the different types of effects that may result from the various infrastructure components, and the relatively large geographical separation among some of the various infrastructure components. These three areas include the Access Road Sub-area, the Mine Site Sub-area, and the Transmission Line – South Option Sub-area. The Access Road Sub-area is 13,835 ha, and has a climate that transitions from coastal at the western edge to continental at the eastern edge. The Mine Site Sub-area is 5,040 ha, and is situated above the tree line in alpine and parkland ecosystems. The Transmission Line – South Option Sub-area is 12,972 ha, and extends from around the Premier Mine Site to the Project Mine Site.

The RSA is 374,433 ha in size, and is the same RSA utilized in the wildlife baseline report (Rescan 2013a). Design of the RSA took into account the area that provides habitat for wildlife species that may come into contact with proposed Project infrastructure during the course of a season or a lifetime. Other ecological factors, such as height of land were also considered when delineating boundaries.

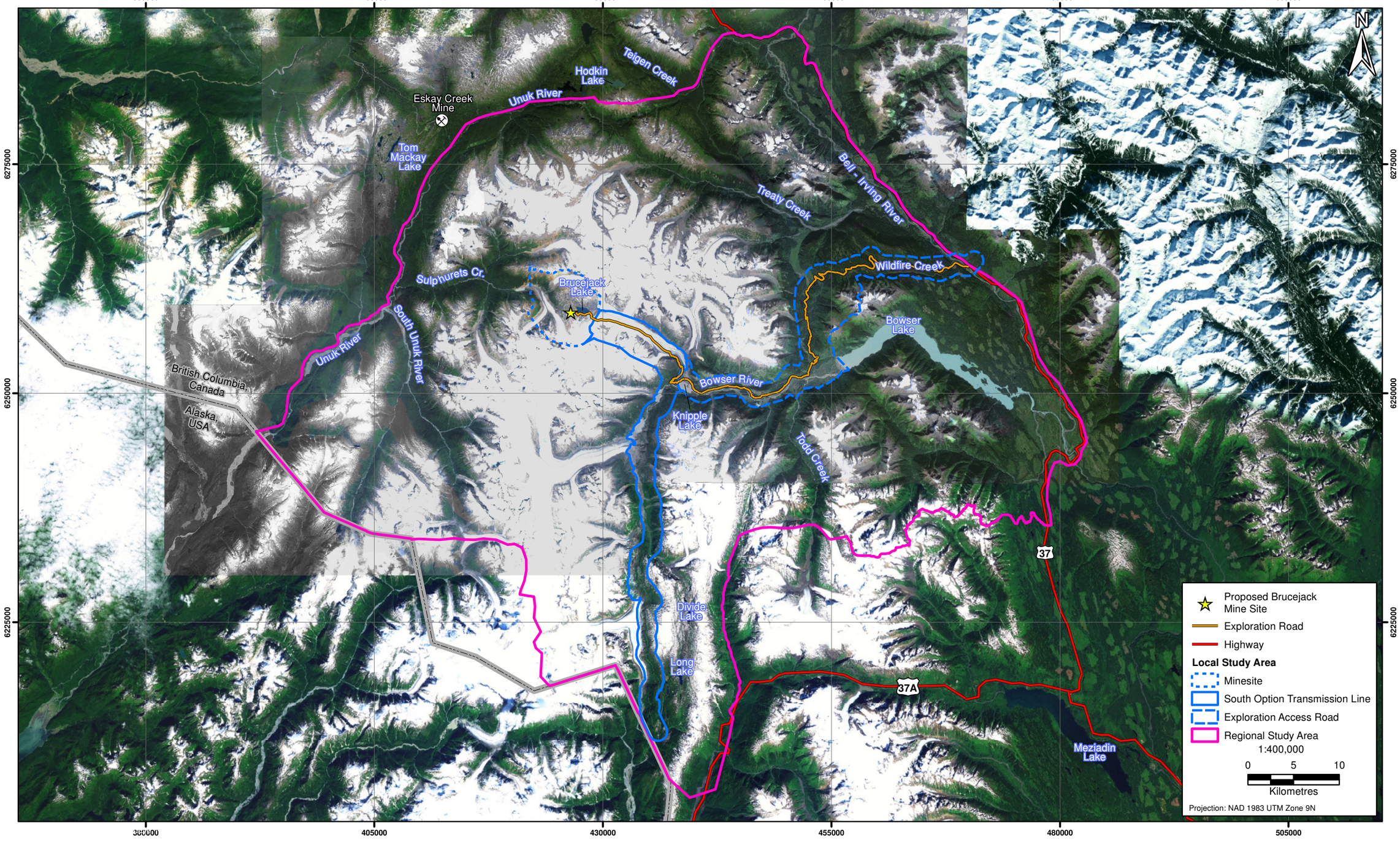

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Figure 5-1

Terrestrial Ecosystems Study Areas

6. Methodology

6. Methodology

6.1 ECOSYSTEM MAPPING

Ecosystem mapping is the stratification of the landscape into similar units based upon ecological features such as terrain, soil, and vegetation communities. It provides information on the type and distribution of ecological units and is a valuable tool for resource planning.

Two different mapping methodologies, Predictive Ecosystem Mapping (PEM) and Terrestrial Ecosystem Mapping (TEM) were used to map ecological features. PEM was used for the RSA and TEM for the LSA. Both methodologies use the BEC system as the basis for ecosystem identification. Predictive Ecosystem Mapping is typically used at smaller scales and is ideal for covering large areas when less resolution is required. Terrestrial Ecosystem Mapping is usually used at larger scales where more detailed information is required. Both are described in the following sections.

6.1.1 Predictive Ecosystem Mapping (PEM) of the Regional Study Area

PEM is an ecosystem mapping method that uses Biogeoclimatic Ecosystem Classification (BEC) system (see Section 6.1-3). While TEM requires manual delineation of ecosystems, PEM is an automated, computer-based method using available imagery, spatial data and ecological knowledge. Rather than being polygon based, it is raster based, with a cell size of 20 cm. It can be used to classify large study areas in a more efficient manner than TEM; therefore, it was used to map the RSA which allows for extensive wildlife habitat modelling. Methods for PEM are presented in Appendix 1.

6.1.2 Terrestrial Ecosystem Mapping of the Local Study Area

TEM involves both the classification of surficial materials and the delineation of ecosystems. Terrain mapping is used as the base layer for ecosystem mapping. Initial mapping involves polygon delineation and the assigning of general attributes to the individual polygons. Detailed attributes are assigned using the field data collected from ground plots.

The following sections summarize the components of TEM.

6.1.2.1 Preliminary Terrain Mapping

Terrain mapping is used as the base layer for both soil and ecosystem mapping. Initial mapping involves polygon delineation and the assigning of general attributes to the individual polygons. Detailed attributes are assigned using the field data collected from ground plots. The use of terrain and TEM information in the development of soil maps is described in Section 6.2.

Terrain mapping is the identification of permanent terrain units based on surficial material, geomorphology and landform. Terrain mapping forms the basis for the surficial material mapping for the study area. Mapping was completed at 1:5,000 scale using PurVIEW software within ArcMap 9.3. PurVIEW enables users to view stereo pairs of digital air photos in 3D at variable scales. A Digital Elevation Model (DEM), created from the provincial Terrain Resource Inventory Mapping (TRIM) data was used to provide a control on the vertical plane (z-axis) to enable on-screen digitizing of polygons that are photogrammetrically accurate.

Terrain polygons are delineated based upon observable characteristics such as surficial material, texture, surface expression, and geomorphic processes. Attributes were described using British

Columbia's Terrain System Classification for British Columbia (Howes and Kenk 1997), and recorded in a database linked to the ArcGIS terrain shapefile.

Slope Analysis

Slope gradient maps were developed as part of the study area terrain and soil assessment. The maps were produced at a scale of 1:20,000 using digital information available from the provincial TRIM database. High-resolution LIDAR data was also used, where it is available, for some parts of the study area. A Geographic Information System (GIS) method using the Spatial Analyst module in ArcGIS was used to generate a percent slope raster data set. This was based on the digital elevation model (DEM) using a 20 m grid spacing for the TRIM sourced data, and a 5 m grid spacing for the LIDAR source data.

Slope classes were created using the standard Terrain Classification categories developed by Howes and Kenk (1997). These original five classes were modified to include seven classes to provide a better differentiation of local slope conditions that affect the soil resources, especially in this area of relatively complex slopes. In particular, the two "level to gentle" slope classes, representing slopes between 0% and 26%, were divided into four classes: level (0 to 2%), very gently sloping (> 2% to 5%), gentle (> 5% to 15%) and moderately gentle (> 15% to 26%). Slope classes are defined in Table 6.1-1.

Table 6.1-1. Slope Classes Use for Slope Gradient Maps

Class	Slope Range	Descriptor
Class 0	0% to 2%	level
Class 1	> 2% to 5%	very gently sloping
Class 2	> 5% to 15%	gently sloping
Class 3	> 15% to 26%	moderately gently sloping
Class 4	> 26% to 50%	moderately sloping
Class 5	> 50% to 70%	moderately steeply sloping
Class 6	> 70%	steeply sloping

6.1.2.2 Preliminary Terrestrial Ecosystem Mapping

Ecological classification is the stratification of ecosystems based on observed similarities. In BC, ecosystem mapping is carried out using Biogeoclimatic Ecosystem Classification (BEC). BEC is a hierarchical classification method that uses a standardized terminology and methodology to assess the interrelationships between physiography, soils and vegetation, which result in the expression of repeated and predictable patterns of ecosystems across the landscape in response to changes in edaphic site conditions, local climate, and regional climate.

At the broadest scale, relatively large areas are classified into zones, subzones and variants. Zones reflect macro-level climate and are primarily determined from relative precipitation and temperature regimes. Zones are divided into subzones based on dominant vegetation or vegetation associations that express regional climate. Subzones may be divided into variants, which account for variations in climate-associated moisture and temperature. The combination of zone, subzone and variant is referred to as a BEC unit.

The next hierarchy is site series, which are classified based upon the climax vegetation community (Banner et al. 1993a). Site series are identified by site conditions, soil conditions and vegetation communities and generally refer to forested ecosystems. Each site series is assigned a two-digit, numeric code. The site series that best reflects the climate of the subzone and is the least influenced by edaphic (soil) conditions is termed "zonal" and other site series within the BEC unit are classified in relation to it.

BEC mapping was carried out using the terrain product as the base layer. Terrain polygons were cut, when appropriate, to parse out identifiable ecosystems. Not all terrain polygons were necessarily cut, as ecological development is often dictated by terrain attributes.

6.1.3 Field Verification of Terrestrial Ecosystem Mapping

Field verification of the preliminary TEM was carried from June to August, 2012. The field data was collected following the guidelines established in the *Field Manual for Describing Terrestrial Ecosystems 2nd Edition* (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998). Field data was collected using a combination of full plots using the FS882 form, Site Visit Form (SIVI), Ground Inspection Form (GIF) as well as visual inspections. For full and site plots, ecosystems were assessed using a 400 m^2 circular plot, with a radius of 11.28 m. Data collected included description of all vegetation layers, complete site information including seral and structural stage, and detailed soils characterization. Soils were classified according to the Canadian System of Soil Classification (Soil Classification Working Group 1998). Site plots involved collecting information on terrain and ecosystems, summary site information, and indicator species, also within a 400 m^2 plot. Information collected at visual inspections included ecosystem and terrain classification, structural stage, as well as any unique site features.

In addition to field verification, objectives of field surveys included the collection of soil samples for laboratory analysis and vegetation tissue sampling for metals analysis.

6.1.4 Final Terrestrial Ecosystem Mapping

Mapping was completed using field plot data to guide the final polygon descriptions. Polygon attributes included terrain modifiers such as texture, parent material, surficial expression and geomorphic process. Ecosystem attributes included information regarding BEC unit, site series, vegetation association, seral stage and structural stage. This information was used to modify the polygon descriptions so that spatially disparate yet ecologically similar polygons were described in a similar manner.

6.1.5 Vegetation Structural Stage

The existing developmental stage of the vegetation within an area was described using structural stage. Vegetation structural information is an important attribute commonly used to describe the habitat characteristics of vegetated ecosystems (RIC 1998). Structural stages range from largely non-vegetated units to old forest (Table 6.1-2). A numeric code is provided for each stage, the details of which are provided in the TEM standards (RIC 1998). Structural stage is a required PEM and TEM attribute (RIC 1999).

Table 6.1-2. Vegetation Structural Stages

Structural Stage Code	Structural Stage
1	Sparse/Bryoid
2	Herb/Dwarf shrub
3	Shrub (Herb)
4	Pole/Sapling
5	Young Forest
6	Mature Forest
7	Old Forest
N/A	Non-vegetated (water/snow/anthropogenic)

Structural stage mapping was completed for the LSA concurrently with the delineation of site series during TEM through air photo interpretation. For the RSA, structural stage was assigned during PEM, based on the classified satellite imagery land cover outputs. On this one-dimensional imagery, some structural stages can be difficult to distinguish from one another. However, field surveys indicated forests were largely structural stages 6 and 7, with a minor component of structural stage 5. Therefore, all areas classified as "conifer" in the land cover map were assumed to be structural stages 6 and 7 for the purposes of this study and the wildlife assessments. Likewise, all areas classified as herb and shrub were assigned a structural stage of 2 and 3, respectively. Manually delineated floodplain forests based on visual image interpretation were assigned a structural stage of 4/5. General assumptions were made for the structural stages of the wetlands identified from the TRIM base. Marshes by definition are herb so were assigned structural stage 2; swamps can be a range of structural stages but are most commonly structural stage 3, thus were assigned to the shrub group.

6.2 SOIL CHARACTERIZATION AND MAPPING

6.2.1 Soils Inspections

Soil inspections (including profile descriptions) were carried out following the guidelines established in the *Field Manual for Describing Terrestrial Ecosystems* (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998). Soils classification, to the order level, is inferred primarily from soil morphologic observation interpretations, with very limited lab data. Soil orders are as described in the Canadian System of Soil Classification (Soil Classification Working Group 1998).

Soil inspection information is used to characterize the Soil Map Units developed for soil mapping. Soil mapping, as described in Section 6.2.3, is largely an interpretive exercise based upon field data, terrain attributes, and local climate and is completed primarily to identify sensitive soils and to support soil salvage and reclamation planning.

6.2.2 Soils Map Units

Soil map units (SMUs) are developed to describe the range of soil resources in the LSA. They are the basic unit used to describe the soil within a mapping polygon. SMU's aggregate the soil development and terrain types into groups that can be interpreted for various uses and/or management. A common example is the use of SMU maps in the development of soil handling plans, prior to anticipated project disturbance. SMU characteristics are interpreted for their relative suitability or management issues for use as root zone materials in reclamation. The availability for salvage may be further impacted by such soil landscape characteristics as soil drainage, and slope gradient, as these may affect operation efficiency, trafficability, and operator safety.

6.3 SENSITIVE ECOSYSTEMS

Sensitive ecosystems are ecosystems that are fragile and/or rare, as defined by the BC MOE (BC MOE 2010). Sensitive Ecosystem Inventory classification uses two primary groupings of ecosystems: Sensitive Ecosystems and Other Important Ecosystems. Sensitive Ecosystem categories are generalised groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecosystem processes, at-risk status, and wildlife habitat values. Criteria for ecological sensitivity include: environmental specificity, susceptibility to hydrological changes, soil erosion, especially on shallow soils, spread of invasive alien plants, and sensitivity to human disturbance.

Other Important Ecosystems are those that have significant ecological and biological values associated with them that can be identified and mapped. Consideration of Other Important Ecosystems is

important for capturing key elements of biodiversity of some project areas, as they can provide recruitment sites for ecosystems at risk or important wildlife habitat requiring recovery or restoration.

Many, but not all, Sensitive Ecosystems are listed and monitored by the BC Conservation Data Centre (BC CDC). Red-listed ecosystems are those that have, or are candidates for, extirpated, endangered or threatened status in BC. Blue-listed ecosystems are those of special concern (formerly vulnerable) in BC. Placing taxa on these lists flags them as being at risk and requiring investigation (BC MOE 2007a).

A search of the online databases maintained by the BC CDC was conducted, and a list of blue- or red-listed ecosystems potentially occurring in the study area was compiled. Rankings depend on factors such as rarity, intrinsic vulnerability, environmental specificity, threats, and long- and short-term trends in population size or area (BC MOE 2007a).

6.3.1 Riparian Ecosystems

Riparian ecosystems occupy the transitional area between a waterbody such as a stream, river or lake, and upland areas. In general, riparian ecosystems are spatially limited and contain unique vegetation communities that are maintained by flood events and high water tables. They serve a number of important ecological functions, such as providing early spring migration pathways, side-channel spawning, rearing habitat, and water temperature regulation as well as bank stability to reduce erosion (Banner and MacKenzie 1998). Many riparian ecosystems are listed by the BC CDC. Those that are not should still be considered valued as they provide unique hydrologic functions and wildlife habitat values.

Riparian ecosystems were identified during mapping, and verified in the field. They were classified using a combination of the Wetlands of BC classification guide (MacKenzie and Moran 2004) and/or the A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region (Banner et al. 1993a). The data collected was used to refine the final ecosystem map.

6.3.2 Wetland Ecosystems

Wetlands are dynamic, low-lying areas on the landscape that are saturated with water long enough to promote wetland or aquatic processes as indicated by poorly-drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment (Warner and Rubec 1997). They include both the wet basin and surrounding transitional areas between wetter zones and upland vegetation (Huel 2000). Wetlands can range from sites that contain small, shallow areas of water that are present for only a few weeks after snow melt, to sites that comprise large, permanent open water zones (Stewart and Kantrud 1971). Wetlands are particularly important ecosystems as they fulfill a wide range of ecological, hydrological, biochemical, and habitat functions (Environment Canada 2003). They maintain water quality, regulate water flow on the landscape, and provide erosion control. They also provide habitat for a wide variety of wildlife, including many economically important game species (Natural Resources Canada 2009).

Wetland ecosystems were classified in the field using the Wetlands of BC classification guide (MacKenzie and Moran 2004). These data were then used to refine the TEM. Wetlands within the LSA are addressed in detail in the Wetlands Baseline Studies report (Rescan 2013b).

6.3.3 Alpine Ecosystems

Alpine ecosystems are defined by a general absence of trees due to climatic and edaphic conditions associated with increases in elevation. Common ecosystems include heath heather, herb meadows and krummholz. Non-vegetated areas, such as permanent snow, ice fields, rock outcrops, and barren soil, are common. Alpine vegetation is considered sensitive because disturbed vegetation may not recover

to pre-disturbance levels, even in the long-term (Frank and del Moral 1986; Forbes, Ebersole, and Strandberg 2001; Mingyu et al. 2009). This situation is particularly true of dwarf shrubs and krummholz. Protecting alpine ecosystems is also a goal of the Cassiar-Iskut Stikine Land and Resource Management Plan (BC ILMB 2000).

Alpine ecosystems are important seasonal habitat, providing forage, breeding areas, and escape terrain from predators and insects. For example, grizzly bear (*Ursus arctos*) forage extensively in alpine and meadow areas in the summer and fall. Caribou (*Rangifer tarandus*) and mountain goat (*Oreamnos americanus*) both use alpine areas for winter habitat (McNay et al. 2009).

6.4 PLANT SPECIES RICHNESS

Species richness is the number of species present within a defined area and is a way to measure environmental homogeneity. Species richness was determined from the plant list collected during field surveys. Differences in species richness between plots is influenced by variations in the abundance of fine-scale habitat features, the development of which is associated with natural and anthropogenic disturbances that may not be beneficial in terms of promoting site productivity and ecological stability.

6.5 PLANTS OF CONSERVATION INTEREST

Rare plant and lichen surveys were conducted to determine the presence of provincially or globally rare plant or lichen species within the LSA and at select sites within the surrounding area. The objectives of the rare plant and lichen survey were to:

- identify locations of rare plants and lichens within the LSA, particularly in areas that overlap with proposed infrastructure;
- identify the type and locations of likely rare plant habitats within the LSA;
- establish complete lists of species present in each site surveyed;
- establish a complete list of flora within the LSA, and
- refine understanding of the regional context of the identified rare plants, in terms of expected range, regional rarity, and habitat.

Rare plant surveys are distinct from ecosystem mapping in goals and methods, with the intention of detecting all species present in a given area. While vegetation and ecosystem mapping focuses on dominant plant and lichen species in vegetation associations, rare plant surveys focus on species that are considered rare at the provincial (BC) and global scales.

In preparation for Project rare plant surveys, a list of potential rare species and associated habitat was compiled. This list included those species that have a conservation-priority S-ranking (subnational conservation ranking; Table 6.5-1), protection under the *Species at Risk Act* (SARA (2002b) and those ranked as threatened or endangered by COSEWIC. In addition to these target rare species, additional research was conducted to identify species previously unreported for the province and possibly of conservation concern. Based on the list of potential rare species, areas of greater likelihood for finding rare species (e.g., cliffs, alpine scree slopes, and ephemeral ponds) were selected for the rare plant surveys.

Table 6.5-1. Rank Status and Definitions

Rank Status	Definition
T	SARA- and COSEWIC-listed Threatened
S1	Extremely rare at the provincial level; 5 or fewer occurrences, or very few remaining individuals; critically imperilled and susceptible to extirpation due to a factor of its biology
S2	Rare at the provincial level; 6 to 20 occurrences, or few remaining individuals; imperilled, may be susceptible to extirpation due to some factor of its biology
S1S2[1]	Extremely rare to rare at the provincial level
S3	Vulnerable at the provincial level; 21 to 100 occurrences; may be rare and local throughout the province or may occur in a restricted provincial range (may be abundant in some places); may be susceptible to extirpation by large scale disturbances
S2S3[1]	Rare to vulnerable at the provincial level
S4	Common at the provincial level; more than 100 occurrences; generally widespread and abundant but may be rare in parts of its range; apparently secure
S3S4[1]	Vulnerable to common at the provincial level
S5	Very common and demonstrably secure at the provincial level; more than 100 occurrences; widespread and abundant, but may be rare in parts of its range
S4S5[1]	Common to very common at the provincial level
SNR	Not ranked; presence confirmed, but province-wide abundance, range and any threats not yet assessed
SNA	No rank status given, used for non-native species
SU	Considered rare but status is not known

[1]A Range Rank (i.e., S2S3) is used when existing information on an element straddles the criteria defining two separate ranks.

6.5.1 Rare Plant and Lichen Survey Design

Surveys were timed to optimize plant identification (e.g., during flowering and/or fruiting) and occurred twice during the summers of 2012 (July 12 to 17 and August 31 to September 3) and 2013 (July 9 to 16 and August 15 to 20).

Survey efforts focused on sites where proposed infrastructure overlapped with likely rare plant habitat within the LSA. Outside of LSA, rare plant surveys were conducted at select sites to provide a regional context of plant and lichen species. Furthermore, presence/not-detected level surveys for rare plants were conducted at general field survey sites within the LSA and RSA.

All surveys were conducted by a qualified botanist using a controlled intuitive wander method, where the surveyor focuses on habitats and landscape features that yield the highest numbers of species and which have the greatest likelihood of harbouring rare species. Intuitive wander methods guide searches through the maximum number of habitats possible during a site survey. Lingering too long in a single habitat greatly reduces the number of species that can be found. By covering a maximum number of habitats in a day's surveys, intuitive wanders also avoid oversampling from the dominant, widespread habitats that tend to have few rare species. The distance covered in each intuitive wander depends on the number of species recorded over spans of time and search effort. Habitats of low species diversity thereby receive less survey time than those having higher species diversity. Habitats with dense concentrations of species may become the focus of an entire day's survey so long as additional species are added to the list with significant frequency up to the end of the field day. In many cases rare species tend to occur in sites having higher overall levels of species diversity. Thus, focusing on species-rich habitats also increases the likelihood of finding rare species.

All taxa encountered were identified to the level of species or lower. Liverworts and microlichens were recorded only as incidental observations. Some species encountered are given provisional names (as with *Peltigera conspersa* ined. or *Draba* sp. nov., as it appears that they represent no published species, and are thus treated as putative species new to science. Uncertain identifications are indicated in the project species list either by a question mark, or as "*cf*." (from the Latin for "compare against"), which represents uncertainty as to how the cited species should be defined, and whether the observed plant or lichen fits within that species' definition. Uncertainty in identification that is reported with a question mark may be the result of having only poorly formed specimens that are difficult to interpret, or may arise from having observed too few individuals to be sure of their characteristics.

When a rare species population was encountered, representative coordinates were recorded with a GPS and a photograph of the plant was taken. The habitat characteristics of the population were recorded, and a general population size was estimated. Where possible, at least one example of each rare species encountered in the rare plant and lichen surveys was documented with a voucher specimen. Voucher specimens were not taken from exceedingly small populations.

When a species was unknown and required additional confirmation techniques, a specimen was collected for later study. Specimens were submitted to the University of British Columbia Herbarium in Vancouver, British Columbia, the largest, most active herbaria in Canada.

Successful rare plant surveys rely first and foremost on accurate species identification. Hence it is important to collect large numbers of specimens at each survey site, and to document species with field photographs. Accurate identifications can be made only by use of a well-stocked taxonomic library. Floras do not cover all taxa encountered in any given project area, and the taxonomy they employ becomes outdated not long after the date of publication. The assurance for accuracy of identification hence relies on original taxonomic literature on genera and species.

Additional quality control is achieved by use of voucher documentation gathered during the field surveys. These are compared against characteristic specimens and photographs of species to ensure correct application of species names, and to detect any distinctions that may reveal species not previously known for a region or those potentially new to science. Comparisons are conducted in a herbarium (natural history museum for plants, lichens, fungi and algae). Herbarium collections at the UBC Herbarium (University of British Columbia, Vancouver) were used for comparison for the 2012 rare plant surveys.

6.6 INVASIVE PLANT SPECIES

Invasive plants generally refer to species (native or non-native) that have the ability to out-compete native species when introduced into natural settings (Haber 1997). The Northwest Invasive Plant Council (NWIPC) provides information regarding invasive plants in Northwestern and Central BC. The NWIPC categorizes invasive plants in terms of their possible risk of invasion and spread. Table 6.6-1 summarizes these invasive plant categories and their associated definitions.

A list of invasive plants, according to the Northwest Invasive Plant Council and the British Columbia *Weed Control Act* (1996) was compiled prior to fieldwork. Detailed invasive plant surveys occurred in conjunction with the rare plant surveys within the LSA and within the surrounding area. Additionally, presence/not detected level surveys for invasive plants were conducted throughout the study area in conjunction with mapping field surveys. The results of the baseline field surveys (i.e., plant species list) were compared to the Northwest Invasive Plant Council and the British Columbia *Weed Control Act* (1996) plant list in order to identify any invasive plants present in the study area.

Table 6.6-1. Northwest Invasive Plant Categories and Definitions

Category	Definition
1 - Extremely Invasive	Invasive plants that pose extreme risk for invasion and spread into undisturbed sites. These species have the ability to become the most abundant plant across a site or area, often becoming the dominant species. The invasive may occur slowly or rapidly.
2 - Very Invasive	Invasive plants that pose a high risk of invasion and spread in undisturbed sites. These species may become very prevalent and abundant across some or all areas within a site, but may require some disturbance to become the dominant species.
3 - Invasive	Invasive plants that pose a moderate risk to invasion and spread into new areas and often requires disturbance to become significantly abundant in an area.
4 - Aggressive or Under Biocontrol	Invasive plants that pose a low to moderate risk of invasion and spread into undisturbed sites. Disturbance is required to allow these species to become abundant.

Source: Northwest Invasive Plant Committee (2010)

6.7 LABORATORY METAL ANALYSIS

As part of the baseline studies, soil, lichens, berries, and plant tissue samples were collected to establish baseline metal concentrations. The metals analyses determine baseline metal levels in the area of proposed infrastructure as well as control sites outside of the expected zone of influence of project environmental effects. This data comprises the basis to evaluate any changes in metal levels due to the Project. Results from the baseline metals analysis may be used for country foods assessments and/or future monitoring programs. All analyses were carried out by ALS Environmental in Burnaby, BC.

6.7.1 Soils Metals

Samples were collected from within the three Sub-areas of the LSA, as well as at reference sites (Reference) outside of the LSA. Baseline soil analyses included testing for concentrations of 31 metals. The interpretation of baseline data included comparing analytical results to the industrial guidelines provided for 19 of the metals, by the Canadian Council of Ministers of the Environment (CCME 2007; Table 6.7-1).

6.7.2 Other Soil Analysis

To characterize the local soils beyond their field observed and metal characteristics, a range of parameters (pH, carbon, texture, $CaCO_3$ equivalence, and cation exchange capacity) were analyzed to provide information on potentially significant characteristics relative to reclamation suitability and soil management. The number of samples tested for each lab parameter or parameters are noted in Table 6.7-2.

6.7.3 Vegetation Tissue Metals

Tracking metal concentrations in plant tissues is a typical requirement for mines applicants and is used to guide reclamation planning and establishing end land use objectives (BC Ministry of Energy and Mines 1998). The metals analyses determines baseline metal levels in the area of proposed infrastructure as well as control sites outside of the expected zone of influence of project environmental effects. This data comprises the basis to evaluate any changes in vegetation tissue metal levels due to the Project. Plant species targeted for metals sampling were based on the following:

- frequency of occurrence/ease of collection;
- known bio-accumulator; and
- likelihood of food source for animals.

Table 6.7-1. A Summary of Detection Limits, and CCME Guidelines

Metals	Detection Limits	CCME Industrial Guideline	Units
Antimony (Sb)	10	20	mg/kg
Arsenic (As)	5	12	mg/kg
Barium (Ba)	1	2,000	mg/kg
Beryllium (Be)	0.5	8	mg/kg
Cadmium (Cd)	0.5	22	mg/kg
Chromium (Cr)	2	87	mg/kg
Cobalt (Co)	2	300	mg/kg
Copper (Cu)	1	91	mg/kg
Lead (Pb)	30	600	mg/kg
Mercury (Hg)	0.005	50	mg/kg
Molybdenum (Mo)	4	40	mg/kg
Nickel (Ni)	5	50	mg/kg
Selenium (Se)	0.5	2.9	mg/kg
Silver (Ag)	2	40	mg/kg
Thallium (Tl)	1	1	mg/kg
Tin (Sn)	5	300	mg/kg
Uranium (U)	0.05	300	mg/kg
Vanadium (V)	2	130	mg/kg
Zinc (Zn)	1	360	mg/kg

Table 6.7-2. A Summary of the Analyses Completed

Parameter	Type of Analysis	Number of Samples
Analysis of Contaminated Sites Regulation (CSR) Metals	Inductively Coupled Argon Spectrograph Analysis	50
Carbon	Total Carbon and Organic Carbon	35 for total C and 10 for organic C
Texture	Grain size analysis using three point texture	18
Cation Exchange Capacity		18
$CaCO_3$ equivalence		11

Uptake, allocation and concentration of various metals differ according to factors such as species, tissue type, time of year, soil type, and distance to source of contamination (Bagatto and Shorthouse 1990; Pugh, Dick, and Fredeen 2002; Mbila and Thompson 2004; Poykio et al. 2005). For this reason, metal concentrations in lichens, leaves and berries were summarized separately depending on each species/tissue type. Metal concentrations with values below the detection limit were replaced with half the value of the detection limit for summary calculations. Although this methodology for addressing what are essentially missing values does not capture the true frequency distribution of the concentrations (Nosal, Legge, and Krupa 2000), assigning values to undetected concentrations in this manner is common practice where it can be assumed the values are not zero, but where the level of risk is low enough not to warrant additional statistical analyses (i.e., with regards to human health; (US EPA 2000).

The above-ground portion of lichens and new growth of woody species (shrubs) were sampled. Soil and root material was removed prior to the sample being placed into a plastic sampling bag (plant tissues) or a paper bag (lichens).

Samples were sent to ALS Environmental in Burnaby, BC, for analysis. Parameters analysed include percent moisture and metals. Variation in detection limits occurs due to calibration differences in the test equipment. Summaries are based on total dry weight. Dry weight represents a relatively objective measure of metal concentration as it is independent of tissue moisture content, which can vary greatly over time and season.

6.8 QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance and quality control (QA/QC) was carried out throughout each phase of the project. Initial polygon delineation for TEM and Terrain mapping was checked for slivers and other errors by senior GIS staff. Once polygons were attributed, image interpretation and data entry was assessed by a senior ecologist and terrain specialist. Data collected in the field was entered into a MS Access database, with the data entry checked by the senior ecologist. Each data card set was assessed for entry and interpretive errors. Review of final mapping of terrain and ecosystems was carried out by a senior terrain specialist and senior ecologist.

7. Results

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7. Results

7.1 ECOSYSTEM MAPPING

PEM, Terrain and TEM maps were prepared for the Project and refined with the results of the field data. PEM mapping was carried out for the RSA using 2008 BEC subzone linework (Version 7.0). The methodology is presented in Appendix 1. Vegetation and soils field forms are presented in Appendix 2, while summary field data is presented in Appendix 3. PEM maps presented at 1:50,000 scale comprise Appendix 4. Terrain and TEM maps are presented at 1:15,000 scale in Appendices 5 and 6, respectively.

7.1.1 Field Surveys

Field studies were conducted during the summer of 2012. They consisted of surveys carried out by wetlands scientists, terrestrial ecologists and soils scientists. Surveys to confirm preliminary TEM and terrain mapping included the completion of 36 detailed ecosystem (FS882) plots, 103 site visit (SIVI) plots, and 162 visual inspections. At a minimum, the field data included the ecosystem classification, terrain classification, and vegetation structural stage attributes. This data was augmented by data collected during wetland surveys, which included an additional 92 plots. Plot distribution is presented in Figure 7.1-1. The field data was used to guide the final ecosystem and terrain classification and mapping, and to support development of soil management units (SMUs).

7.1.2 Predictive Ecosystem Mapping of the Regional Study Area

Nine BEC units occur within the RSA, including both coastal and interior units (Table 7.1-1). Six of the nine BEC units are forested and cover about 42% of the RSA, while the three alpine and parkland BEC zones collectively contribute more than 58% of the RSA.

Table 7.1-1. BEC Units in the Regional Study Area

BEC Unit Name	Description	BEC Unit Label	RSA Extent (ha)	RSA Extent (%)
Boreal Altai Fescue Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	BAFAunp	36,843	10
Coastal Mountain-heather Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	CMAunp	11,2604	30
Coastal Western Hemlock - Wet Maritime Subzone	Low elevation forest (coastal)	CWHwm	11,883	3
Engelmann Spruce – Subalpine Fir undifferentiated Subzone	Subalpine forest (interior)	ESSFun	25,015	7
Engelmann Spruce – Subalpine Fir Wet Very Cold Subzone	Subalpine forest (interior)	ESSFunp	12,810	3
Interior Cedar Hemlock - Very Wet Cold Subzone	Low elevation forest (interior)	ICHvc	59,522	16
Mountain Hemlock, Windward Moist Maritime	Subalpine forest (coastal)	MHmm1	4,570	1
Mountain Hemlock - Leeward Moist Maritime Variant*	Subalpine forest (coastal)	MHmm2	43,498	12
Mountain Hemlock, Moist Maritime Parkland	Alpine/Parkland	MHmmp	67,676	18
Total			374,422	100

Generally the coastal BEC units (CWHwm, MHmm1, MHmm2 and CMAunp) are more prevalent in the in the west, while the transitional and interior BEC units (ICHvc, ESSFun, ESSFunp and BAFAunp) are more common in the east. In the coastal areas, the typical elevation transition is from CWHwm along the valley bottoms to about 800 m, depending on continentality, where it is succeeded by the MHmm2. The MHmm2 is succeeded by the CMAunp where late season snowpack persists to the point that forest does not grow. Parklands units occur in the transition from forest to alpine, where edaphic and microclimate conditions allow for variations in the depth of snowpack, facilitating a mosaic of tree islands and non-forested alpine ecosystems.

7.1.2.1 Boreal Altai Fescue Alpine — Parkland (BAFAunp)

BAFAunp is found at high elevations in the provinces' interior. It is the transitional zone in between forested subzones at lower elevations and the true alpine at higher elevations (B.C. Ministry of Forests and Range 2006). Vegetation is dominated by spruce and subalpine fir (B.C. Ministry of Forests and Range 2006), dwarf willows, sedges, lichens and grasses (Banner et al. 1993a).

7.1.2.2 Coastal Mountain-Heather Alpine — Parkland (CMAunp)

The CMAunp occurs at high elevations on the coastal mountains. The parkland region is the transitional zone in between forested subzones at lower elevations and the true alpine at higher elevations (B.C. Ministry of Forests and Range 2006). This zone is a very wet environment, and tends to have a deeper snowpack which extends to lower elevations than other BEC alpine zones (B.C. Ministry of Forests and Range 2006) which in turn extends the zone down in elevation as compared to other alpine zones. The CMA parkland vegetation consists of mountain heathers (*Cassiope* spp.), while mountain hemlock (*Tsuga mertensiana*), yellow-cedar (*Chamaecyparis nootkatensis*) and subalpine fir (*Abies lasiocarpa*) are the treeline tree species that are primarily in krummholz form (BC Ministry of Forests and Range 2006).

7.1.2.3 Wet Maritime Coastal Western Hemlock Subzone (CWHwm)

The CWHwm is the most northerly of the CWH subzones, and has heavier snow and a shorter growing season than more southerly subzones (Banner et al. 1993b). It occurs at elevations from sea level to 600 m. The summer is cool and moist, fall is very wet, and winter is cool and has heavy, wet snowfalls. Based on data from the nearby town of Stewart, which is representative of this subzone, mean annual temperature is around 5.1°C while mean annual precipitation is around 1,843 mm (Banner et al. 1993). This subzone is noted for its low plant species diversity compared to southerly subzones. Zonal sites are typically dominated by western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*). Blueberries, both oval-leaved blueberry (*Vaccinium ovalifolium*) and Alaskan blueberry (*Vaccinium alaskaense*), are abundant in the understory (except in floodplain sites), and typically occur with false azalea (*Menziesia ferruginea*), bunchberry (*Cornus canadensis*), five-leaved bramble (*Rubus pedatus*), and spiny wood fern (*Dryopteris expansa*). Western red cedar (*Thuja plicata*), yellow cedar (*Chamaecyparis nootkatensis*) and amabalis fir (*Abies amabilis*) are uncommon or absent (Banner et al. 1993a).

7.1.2.4 Leeward Moist Maritime Mountain Hemlock Variant (MHmm2)

The Mountain Hemlock (MH) zone is the subalpine zone of BC's Coast Mountains, and is the coastal counterpart to the interior's ESSF zone. As with the ESSF, continuous forests give way to patchy clumps of trees, subalpine heath and lush meadows at higher elevations (Banner et al. 1993b).

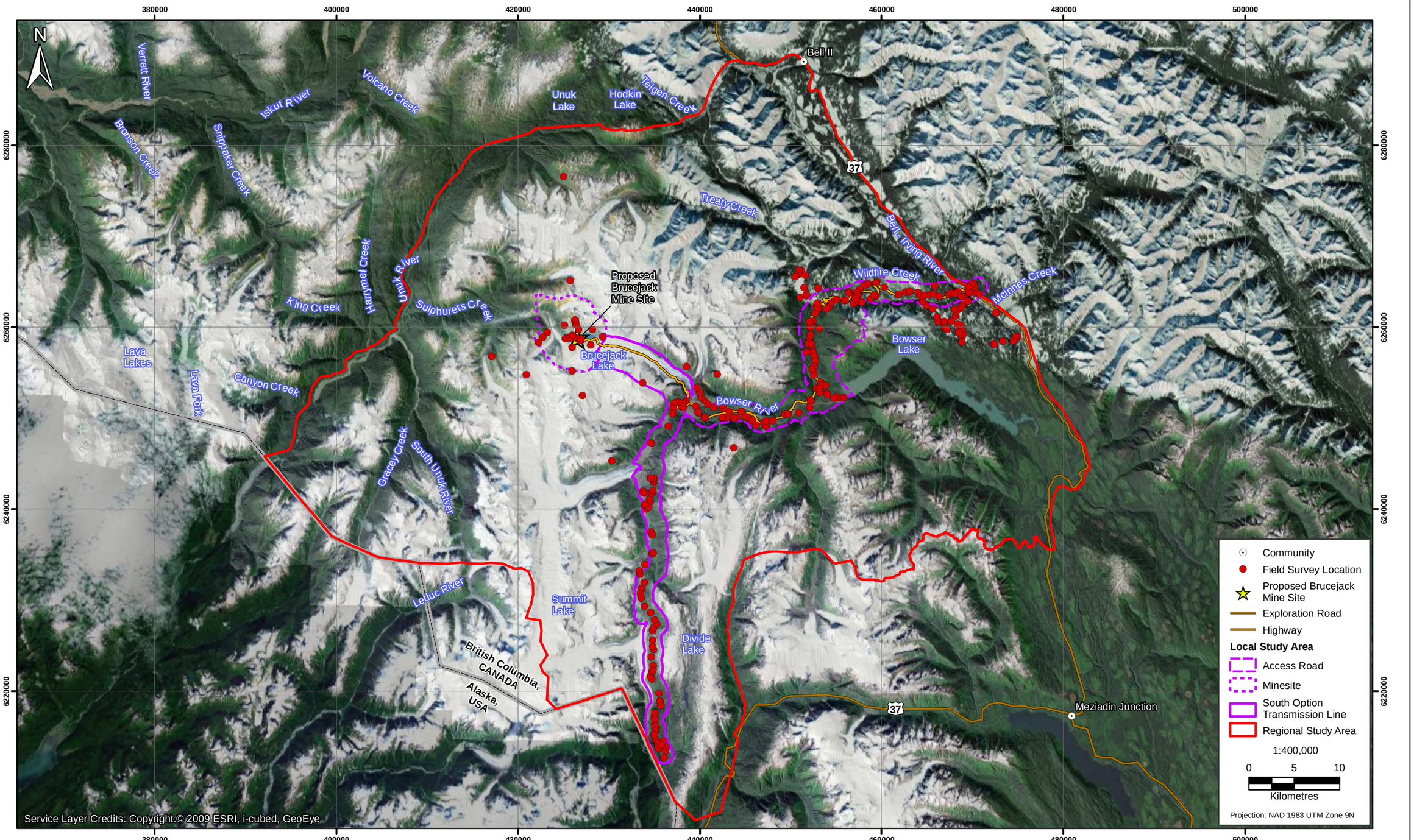

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Figure 7.1-1

TEM Field Survey Locations

The ecological classification of the Mountain Hemlock BEC unit in the RSA is currently incomplete; subzones and/or variants are not yet recognized or documented for this area. However, data collected by field personnel during the 2008 baseline field studies for the adjacent KSM project (which has the same RSA) resulted in reclassification of the RSA location from MHun subzone to the MHmm2 variant. The MHmm2 in the region generally starts at 900 to 950 m in elevation, becomes parkland at 1,100 to 1,150 m and alpine at 1,450 m (Banner 2009). It has a climate transitional between the coast and interior, characterized by long, moist, cold winters and short, cool, moist summers. Heavy snow, a short growing season, wet soils and exposure to wind and cold reduces the forest productivity in this zone (Banner et al. 1993). Forests on zonal sites are dominated by amabalis fir (*Abies amabilis*) and mountain hemlock, with western hemlock occurring at lower elevations and subalpine fir occurring less commonly (Pojar, Klinka, and Demarchi 1991).

7.1.2.5 Very Wet Cold Interior Cedar Hemlock (ICH) Subzone (ICHvc)

The ICH zone is a transitional zone between the wetter CWH zone to the west and the drier Sub-Boreal Spruce (SBS) zone to the east, and contains both coastal and interior plant species. The ICHvc ranges in elevation from 240 to 1,000 m. The subzone is cool and moist year-round with a thick and long-lasting snowpack, thus zonal sites are typically productive forests containing moisture-loving species such as devil's club (*Oplopanax horridus*) and oak fern (*Gymnocarpium dryopteris*; (Ketcheson et al. 1991; Banner et al. 1993b).

7.1.2.6 Wet Very Cold Engelmann Spruce — Subalpine Fir Subzone (ESSFwv)

The ESSF zone is broadly transitional between true coastal and interior BEC units. The ESSF zone is the highest forested zone in BC, occurring on rugged mountainous terrain throughout the province at elevations above other forested zones (Coupe et al. 1991; Banner et al. 1993). The ESSFwv (wet, very cold ESSF) is the most northerly ESSF subzone in BC, occupying the northwestern part of the province (north of the Skeena River), typically between 900 and 1,550 m in elevation. It is one of the wetter subzones in the ESSF, with mean annual precipitation ranging from 650 to 1,100 mm (Banner et al. 1993). It has a snowier winter and a moister growing season than other ESSF subzones. Growing season moisture deficits are unlikely (Banner et al. 1993a). Snow may persist for six to nine months (Banner et al. 1993a).

The forests are predominately coniferous. Zonal sites represent moderately productive forests, and are dominated by subalpine fir. The ESSFwv subzone commonly has a moderately dense ericaceous shrub layer and a very productive herbaceous layer on zonal sites (Coupe, Stewart, and Wikeem 1991). The dominant understory plants are black huckleberry, oval-leaved blueberry, false azalea, five-leaved bramble, bunchberry, red-stemmed feathermoss (*Pleurozium schreberi*), and leafy liverworts.

7.1.3 Terrestrial Ecosystem Mapping of the Local Study Area

Terrestrial ecosystem mapping within the LSA was completed to reflect the updates to the provincial BEC version in 2012. The 2012 changes within the Project area resulted in the splitting of distinct ESSFunp and MHmmp parkland polygons from the CMAunp and BAFAunp units, which previously combined parkland and alpine together into a single BEC label. The BEC units mapped throughout the LSA that are not described previously for the RSA are briefly described below.

7.1.3.1 Undifferentiated Engelmann Spruce — Subalpine Fir Parkland (ESSFunp)

The ESSFunp, previously included within the BAFAunp label, is found at high elevations within the eastern portions of the LSA, primarily within the exploration Access Road Sub-area. It is the transitional zone between the forested ESSFun subzone at lower elevations and the true alpine zone (BAFAun) at higher elevations (B.C. Ministry of Forests and Range 2006). Vegetation within the parkland unit is

dominated by spruce and subalpine fir (B.C. Ministry of Forests and Range 2006), dwarf willows, sedges, lichens and grasses (Banner et al. 1993a).

7.1.3.2 Moist Maritime Mountain Hemlock Parkland (MHmmp)

The MHmmp, previously included within the CMAunp label, occurs at high elevations within the western and southern portions of the LSA. This parkland unit is the transitional zone between the forested MHmm1 and MHmm2 subzone/variants at lower elevations and the true alpine zone (CMAun) at higher elevations (B.C. Ministry of Forests and Range 2006). This zone is a very wet environment, and tends to have a deeper snowpack which extends to lower elevations than other BEC alpine zones (B.C. Ministry of Forests and Range 2006) which, in turn, extends the zone to lower elevations than other alpine zones. The MHmmp vegetation consists largely of mountain-heathers (*Cassiope* spp.), while mountain hemlock (*Tsuga mertensiana*), yellow-cedar (*Chamaecyparis nootkatensis*) and subalpine fir (*Abies lasiocarpa*) are the treeline tree species, which primarily exhibit a krummholz growth form (BC Ministry of Forests and Range 2006).

7.1.3.3 Windward Moist Maritime Mountain Hemlock Zone Variant (MHmm1)

The Mountain Hemlock (MH) zone is the highest elevation forested zone within BC's Coast Mountains, and is the coastal counterpart to the interior's ESSF zone. As with the ESSF zone, continuous forests give way to patchy clumps of trees, subalpine heath and lush meadows (parkland ecosystems) at higher elevations (Banner et al. 1993b).

Ecological data collected by field personnel during the 2008 baseline field studies for the adjacent KSM project (which shares a consistent RSA) resulted in reclassification of the RSA location from the undifferentiated MHun subzone to the MHmm2 variant. The MHmm2 in the region generally starts at 900 to 950 m in elevation, becomes parkland at 1,100 to 1,150 m and alpine at 1,450 m (Banner 2009). Towards the southern end of the Transmission Line – South Option Sub-area, the windward MHmm1 variant replaces the MHmm2 variant. Consistent with the MHmm2 variant, forests on zonal sites are dominated by amabalis fir (*Abies amabilis*) and mountain hemlock, with western hemlock occurring at lower elevations and subalpine fir occurring less commonly(Pojar, Klinka, and Demarchi 1991).

The LSA is divided into the following three smaller local study areas, or sub-areas, for purposes of discussion:

1. Mine Site Sub-area;
2. Access Road Sub-area;
3. Transmission Line – South Option Sub-area.

The division was undertaken in order to group together similar ecosystems and similar potential impacts. As the ecosystems, terrain and soils associated with each subarea differ quite substantially, they are addressed separately. The proposed Mine Site occurs within an area comprised largely of non- and sparsely vegetated alpine ecosystems, the proposed Transmission Line – South Option grades from old forest in the south to early seral ecosystems and non-vegetated areas in the north, while the exploration access road is dominated by forested ecosystems, including wetlands and floodplain ecosystems. The distribution of surficial materials and terrestrial ecosystems mapped within the respective sub-areas are presented within tables under the sub-area headings.

Table 7.1-2 summarizes the BEC units mapped within each of the Sub-areas.

Table 7.1-2. BEC Unit Summary within the LSA

BEC Unit	Mine Site	Access Road	TLSO	Total (ha)	% LSA
ICHvc	-	6,181.0	-	6,181.0	19%
ESSFwv	-	6,406.6	40.0	6,446.6	20%
ESSFwvp	-	506.5	61.3	567.8	2%
MHmm1	-	-	1,562.8	1,562.8	5%
MHmm2	678.8	4.3	4,151.9	4,834.9	15%
MHmmp	608.8	-	3,253.9	3,862.7	12%
CMAun	3,752.7	-	3,626.3	7,379.0	23%
BAFAun	-	735.8	3.6	739.4	2%
UNCLASSIFIED	-	0.0	272.0	272.0	1%
Total	**5,040.3**	**13,834.1**	**12,971.8**	**31,846.2**	**100%**

A total of 1,035 terrain polygons and 1,428 TEM polygons were delineated for the entire LSA. Polygon areas range from as large as approximately 3,100 ha (a glacier) to less than 1 ha. The median TEM polygon size is 11.0 ha. The original mapping was refined by the field data, in order to have the attributes ascribed to best reflect on the ground conditions. Terrain maps are presented at 1:15,000 scale in Appendix 5.

Table 7.1-3 summarizes the surficial materials (based on the leading decile within the terrain database) within each of the sub-areas.

Table 7.1-3. Surficial Material Summary within the LSA

Surficial Material[1]	Map Code	Mine Site	Access Road	TLSO	Total (ha)	% LSA
Moraine	M	559.1	4,688.9	2,975.3	8,223.2	26%
Colluvium	C	854.0	3,661.5	3,172.7	7,688.2	24%
Ice	I	1,835.0	38.2	2,768.7	4,641.9	15%
Rock	R	1,540.3	675.4	1,788.8	4,004.5	13%
Fluvial	F	10.8	1,988.6	108.7	2,108.1	7%
Fluvial; active	FA	0.0	995.1	524.3	1,519.4	5%
Glaciofluvial	FG	0.0	646.5	415.8	1,062.2	3%
Water Features	various	81.9	580.4	394.1	1,056.4	3%
Weathered Bedrock	D	141.8	131.8	431.5	705.1	2%
Organic	O	4.3	398.5	10.0	412.8	1%
Glaciolacustrine	LG	0.0	0.0	270.5	270.5	1%
Anthropogenic	A	0.0	0.0	56.6	56.6	0%
Unclassified	(blank)	0.0	0.0	55.0	55.0	0%
Undifferentiated	U	0.0	23.0	0.0	23.0	0%
Lacustrine	L	13.0	6.4	0.0	19.5	0%
Total		**5,040.3**	**13,834.1**	**12,972.1**	**31,846.5**	**100%**

[1] *Based on leading surficial material decile*

Terrain and Ecosystems of the Mine Site Sub-Area

Tables 7.1-4 and 7.1-5 depict the surficial materials and terrestrial ecosystems, respectively, mapped within the Mine Site Sub-area.

Table 7.1-4. Surficial Materials Mapped within the Mine Site Sub-area

Surficial Material[1]	Map Code	Area (ha)	% of Mine Site	% of LSA
Ice	I	1,835.0	36.41	5.8
Rock	R	1,540.3	30.56	4.8
Colluvium	C	854.0	16.94	2.7
Moraine	M	559.1	11.09	1.8
Weathered Bedrock	D	141.8	2.81	0.5
Water Features	various	81.9	1.62	0.3
Lacustrine	L	13.0	0.26	<0.1
Fluvial	F	10.8	0.21	<0.1
Organic	O	4.3	0.09	<0.1
Total		**5,040.3**	**100.00%**	**16.00%**

[1] *Based on leading surficial material decile*

Table 7.1-5. Terrestrial Ecosystems Mapped within the Mine Site Sub-area

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of Mine Site
CMAun	Glacier	GL	Non-vegetated	1,505.5	29.9
CMAun	Rock Outcrop	RO	Sparsely Vegetated	984.0	19.5
CMAun	Talus	TA	Sparsely Vegetated	335.8	6.7
CMAun	Fescue Lichen	FC	Drier Herb	179.2	3.6
CMAun	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	137.8	2.7
CMAun	Moraine	MN	Sparsely Vegetated	133.8	2.7
CMAun	Herb Meadow	AM	Mesic Herb	117.6	2.3
CMAun	Cliff	CL	Sparsely Vegetated	110.4	2.2
CMAun	Lake	LA	Non-vegetated	74.8	1.5
CMAun	Cryptogam - Altai Fescue	CG	Drier Herb	44.0	0.9
CMAun	Permanent Snow/Ice	PN	Non-vegetated	41.9	0.8
CMAun	Exposed Soil	ES	Sparsely Vegetated	41.6	0.8
CMAun		MZ		31.7	0.6
CMAun	Pond	PD	Non-vegetated	7.3	0.1
CMAun	Herb Wetland (undescribed)	WH	Wetland Shrub/Herb	5.8	0.1
CMAun	River	RI	Non-vegetated	1.5	<0.1
MHmm2	Moraine	MN	Sparsely Vegetated	139.4	2.8
MHmm2	HmBa - Blueberry	MB	Mesic Forest	134.5	2.7
MHmm2	Glacier	GL	Non-vegetated	125.0	2.5
MHmm2	Krummholz	KH	Parkland Forest/Krummholz	99.1	2.0
MHmm2	Talus	TA	Sparsely Vegetated	68.9	1.4
MHmm2	Rock Outcrop	RO	Sparsely Vegetated	49.0	1.0
MHmm2	Deciduous Shrub	51	Wetter Shrub/Herb	37.4	0.7

(continued)

Table 7.1-5. Terrestrial Ecosystems Mapped within the Mine Site Sub-area (completed)

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of Mine Site
MHmm2	BaHm - Oak fern	MO	Mesic Forest	15.8	0.3
MHmm2	Cliff	CL	Sparsely Vegetated	6.4	0.1
MHmm2	Parkland Forest	PK	Parkland Forest/Krummholz	1.6	<0.1
MHmm2	BaHm - Twistedstalk	MT	Moist Forest	1.1	<0.1
MHmm2	Herb Meadow	AM	Mesic Herb	0.6	<0.1
MHmmp	Krummholz	KH	Parkland Forest/Krummholz	125.3	2.5
MHmmp	Moraine	MN	Sparsely Vegetated	120.1	2.4
MHmmp	Talus	TA	Sparsely Vegetated	92.1	1.8
MHmmp	Glacier	GL	Non-vegetated	85.3	1.7
MHmmp	Rock Outcrop	RO	Sparsely Vegetated	82.2	1.6
MHmmp	Herb Meadow	AM	Mesic Herb	54.8	1.1
MHmmp	Fescue Lichen	FC	Drier Herb	22.6	0.4
MHmmp	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	12.4	0.2
MHmmp	Parkland Forest	PK	Parkland Forest/Krummholz	11.8	0.2
MHmmp	Deciduous Shrub	51	Wetter Shrub/Herb	2.1	<0.1
Total				**5,040.3**	**100.0**

Non-vegetated and sparsely vegetated ecosystems dominate the high elevation Mine Site Sub-area, covering approximately 80% of the total Sub-area. Of this, approximately 37% consists of non-vegetated ecosystems including glaciers, permanent snow/ice, lakes and ponds. Sparsely vegetated ecosystems include rock outcrops, talus and moraine. Patches of snow, névé, and firn persist late into the year. Vegetation cover increases to the west towards the Sulphurets Valley. In this area, vegetation classes of the Alpine Group are present as a mosaic across the landscape, the distribution of which is determined by soil depth, drainage, and microclimate (Plate 7.1-1). In the immediate vicinity of Brucejack Lake, much of the surficial material is derived from from weathered talus and bedrock, as well as glacial till. Much of the existing exploration camp infrastructure is built upon this material (Plates 7.1-2 and 7.1-3).

Typical of alpine ecosystems in the northern coastal areas of BC, surficial materials found in the Mine Site Sub-area are dominated by morainal veneers over bedrock, colluvium, and weathered bedrock. Much of the moraine is recently exposed due to recent and ongoing deglaciation. It is poorly sorted and characterized by very high coarse fragment contents, often exceeding 70% within a matrix of sandy loam and silt loam mineral material. Pedogenesis is very limited, due to the short amount of time that soil forming processes (weathering and inputs) have been active within the parent material. Soils are classified as Orthic Regosols and, occasionally, as Dystric Brunisols.

Most of the ecosystems within the Mine Site Sub-area are early seral, disclimax or edaphic climax ecosystems. Early seral ecosystems, such as the vast areas mapped as alder thicket, are those that develop early in the successional status chrono-sequence. These include non-vegetated, pioneer seral and young seral communities. Edaphic ecosystems are those that are maintained by local climate and soil conditions that enable an ecosystem to perpetuate itself. For example, ecosystems affected by saturated soils will develop specific plant assemblages that will be maintained as long as those soil conditions remain. Such is the case with late snowbed ecosystems (Alpine Nivation), which are maintained by the persistence of snowpack late into the growing season. Disclimax ecosystems are those that are maintained by repeated disturbance events, such as avalanche tracks.

Plate 7.1-1. General Landscape photo of a mosaic of Alpine Group ecosystems near Brucejack Exploration Camp.

Plate 7.1-2. Surficial material at the Mine Site – looking east.

Plate 7.1-3. Surficial material at the Mine Site- looking west.

Three BEC units were mapped within the Mine Site Sub-area, the CMAun, MHmmp and MHmm2. Although the current (2012) version of the provincial BEC classification identifies MHmmp within nearly the entire upper Sulphurets valley, MHmm2 was expanded during the TEM on some warm aspects to reflect the dense forested canopies on some slopes. The CMAun subzone occurs at high elevations throughout the coastal mountains of BC. The MHmmp (parkland) subzone is transitional between the forested subzones, such as CWHwm and MHmm2 at lower elevations, and the CMAun at higher elevations (B.C. Ministry of Forests and Range 2006). This zone is a relatively moist environment, and tends to have a deeper snowpack and begin at lower elevations than the other alpine zones (B.C. Ministry of Forests and Range 2006).

Vegetation community development in the Mine Site Sub-area is influenced by the recent deposition of the soil parent material, excessive snow pack, wind and cold temperatures. For example, Alpine Tundra Class vegetation communities are dominated by hardy ericaceous shrubs that can withstand the desiccating winds common in alpine environments. Alpine Meadow Class vegetation communities develop in areas of deep winter snowpack over deep or fine textured soils, thus confining the vegetation community to those plants that can tolerate or thrive in saturated conditions. Common vegetation classes mapped and confirmed in the Mine Site Sub-area include Alpine Fellfield, Alpine Heath and Alpine Meadows. For a complete list of ecosystems mapped within the Mine Site Sub-area, please see Table 7.1-3.

Alpine Fellfield Class (Af)

Alpine Fellfields (Plate 7.1-4) are exposed ecosystems where the effects of frost and wind give rise to a characteristic low plant cover. Soils are either absent or exist as thin veneers, often derived from *in-situ* bedrock weathering, remnant glacial till, and colluvium. Thin annual snowpacks leads to active freeze–thaw cycles that act to push plants out of the soil. Since soils are typically very high in coarse fragments, vegetation cover is thin and growth is poor. Fellfields are commonly populated by cushion plants (tufted perennials that grow in dense mats close to the ground) and cryptograms. Alpine Fellfields occupy approximately 5% of the Mine Site Sub-area.

Plate 7.1-4. Alpine Fellfield ecosystems near Brucejack Exploration Camp

Alpine Heath Class (Ah)

Alpine heath ecosystems (Plate 7.1-5) are mountain-heather–dominated snowbeds that are widespread and common throughout British Columbia in snow-accumulating sites and upon stable substrates. Moderate snow accumulations are of intermediate depth between tundra and nivation ecosystems. Mountain-heather species are always prominent and site moisture is typically mesic and drier. Alpine Heath occupies approximately 3% of the Mine Site Sub-area.

Plate 7.1-5. General landscape photo of Alpine heath ecosystem.

Alpine Meadow Class (Am)

Alpine meadow ecosystems are forb-dominated (or large sedge–dominated) ecosystems of subalpine and alpine elevations (Plate 7.1-6). Vegetation typically has high cover and stature. These ecosystems occur on fresh to moist, usually well-developed, soils that have a continuous winter snowpack. Sites with seepage or unstable soils favour the Alpine Meadow Class over alpine heath ecosystems. Alpine meadows occupy approximately 3.5% of the Mine Site Sub-area.

Plate 7.1-6. Alpine meadow ecosystem at Plot BJ012.

Terrain and Ecosystems of the Access Road Sub-Area

Tables 7.1-4 and 7.1-5 present the spatial extent of terrain and ecosystems mapped in the Access Road Sub-area. The Access Road Sub-area traverses 40 km of forested landscapes moving west to east from Highway 37 to Knipple Lake. Terrain is dominated by morainal deposits from the junction at Highway 37 to Bowser Lake, after which colluvium, glaciofluvial and fluvial deposits are predominant. Starting at the crossing of the Bell River, moraine deposits intermix with glaciofluvial deposits that have overridden the moraine during episodic melting and advance. As the road travels west along Wildfire Creek the glaciofluvial deposits become less common (as they are associated with glacial melt in the Bell River Valley), and glacial till predominates. For the most part, these soils are Podzols (Plate 7.1-7) and Brunisols, with high coarse fragment content and silty clay loam matrix. Where disturbance such as fire, avalanche and landslides are absent or infrequent, the landscape is dominated by mature forested ecosystems, many of them exceeding 350 years in age (Plate 7.1-8).

Tables 7.1-6 and 7.1-7 depict the surficial materials and terrestrial ecosystems, respectively, mapped within the Access Road Sub-area.

Plate 7.1-7. Podzolic soil along the Brucejack exploration access road, plot K002.

Plate 7.1-8. Mature forested ecosystems close to Highway 37, along the exploration access road.

Table 7.1-6. Surficial Materials Mapped within the Access Road Sub-area

Surficial Material[1]	Map Code	Area (ha)	% of Access Road	% of LSA
Moraine	M	4,688.9	34%	14.7
Colluvium	C	3,661.5	26%	11.5
Fluvial	F	1,988.6	14%	6.2
Fluvial; active	FA	995.1	7%	3.1
Rock	R	675.4	5%	2.1
Glaciofluvial	FG	646.5	5%	2.0
Water Features	various	580.4	4%	1.8
Organic	O	398.5	3%	1.3
Weathered Bedrock	D	131.8	1%	0.4
Ice	I	38.2	0%	0.1
Undifferentiated	U	23.0	0%	<0.1
Lacustrine	L	6.4	0%	<0.1
Total		**13,834.1**	**13,834.1**	**43%**

[1] *Based on leading surficial material decile*

Table 7.1-7. Terrestrial Ecosystems Mapped within the Access Road Sub-area

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of Access Road
BAFAun	Talus	TA	Sparsely vegetated	285.5	2.1
BAFAun	Herb Meadow	AM	Mesic Herb	136.1	1.0
BAFAun	Exposed Soil	ES	Sparsely vegetated	126.0	0.9
BAFAun	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	69.3	0.5
BAFAun	Permanent Snow/Ice	PN	Non-vegetated	45.4	0.3
BAFAun	Fescue Lichen	FC	Drier Herb	33.4	0.2
BAFAun	Rock Outcrop	RO	Sparsely vegetated	25.5	0.2
BAFAun	Moraine	MN	Sparsely vegetated	10.3	0.1
BAFAun	Krummholz	KH	Parkland Forest/Krummholz	4.2	<0.1
ESSFwv	BlHm - Azalea	FA	Mesic Forest	1,495.4	10.8
ESSFwv	Deciduous Shrub	51	Wetter Shrub/Herb	1,018.8	7.4
ESSFwv	Bl - Devil's club - Lady fern	FD	Wetter Forest	805.2	5.8
ESSFwv	Bl - Oak fern - Heron's-bill	FO	Mesic Forest	685.3	5.0
ESSFwv	BlHm - Feathermoss	FF	Drier Forest	358.5	2.6
ESSFwv	Bl - Lady fern - Horsetail	FL	Wetland Forest	316.9	2.3
ESSFwv	Rock Outcrop	RO	Sparsely vegetated	291.4	2.1
ESSFwv	Undescribed floodplain	FP	Floodplain Forest	242.5	1.8
ESSFwv	Herb Wetland (undescribed)	WH	Wetland Shrub/Herb	240.6	1.7
ESSFwv	Lake	LA	Non-vegetated	153.6	1.1
ESSFwv	Bl - Valerian - Sickle moss	FV	Wetter Forest	109.7	0.8
ESSFwv	Shrub Wetland (undescribed)	WS	Wetland Shrub/Herb	103.7	0.7

(continued)

Table 7.1-7. Terrestrial Ecosystems Mapped within the Access Road Sub-area (continued)

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of Access Road
ESSFwv	BlPl - Cladonia	LC	Drier Forest	96.6	0.7
ESSFwv	River	RI	Non-vegetated	83.5	0.6
ESSFwv	Bl - Horsetail - Glow moss	FH	Wetter Forest	80.8	0.6
ESSFwv	Talus	TA	Sparsely vegetated	62.5	0.5
ESSFwv	Exposed Soil	ES	Sparsely vegetated	46.1	0.3
ESSFwv		Fm03		45.3	0.3
ESSFwv	Herb Meadow	AM	Mesic Herb	36.3	0.3
ESSFwv	Willow Thicket	WT	Wetter Shrub/Herb	28.8	0.2
ESSFwv	BlHm - Heron's-bill	MH	Mesic Forest	26.6	0.2
ESSFwv	Non-forested Wetland	WE	Wetland Shrub/Herb	19.8	0.1
ESSFwv	Sx - Devil's club	SD	Moist Forest	11.4	0.1
ESSFwv	Gravel Bar	GB	Sparsely vegetated	10.1	0.1
ESSFwv	Shallow Open Water	OW	Non-vegetated	9.2	0.1
ESSFwv	Cliff	CL	Sparsely vegetated	8.3	0.1
ESSFwv	Pond	PD	Non-vegetated	6.5	<0.1
ESSFwv	Krummholz	KH	Parkland Forest/Krummholz	4.9	<0.1
ESSFwv	Fescue Lichen	FC	Drier Herb	3.6	<0.1
ESSFwv	Alder Thicket	AT	Deciduous Shrub	2.3	<0.1
ESSFwv	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	1.4	<0.1
ESSFwv	Cryptogam - Altai Fescue	CG	Drier Herb	0.5	<0.1
ESSFwv	Road Surface	RZ	Non-vegetated	0.4	<0.1
ESSFwvp	Herb Meadow	AM	Mesic Herb	141.8	1.0
ESSFwvp	Talus	TA	Sparsely vegetated	122.7	0.9
ESSFwvp	Krummholz	KH	Parkland Forest/Krummholz	83.7	0.6
ESSFwvp	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	66.6	0.5
ESSFwvp	Deciduous Shrub	51	Wetter Shrub/Herb	44.8	0.3
ESSFwvp	Parkland Forest	PK	Parkland Forest/Krummholz	29.6	0.2
ESSFwvp	Exposed Soil	ES	Sparsely vegetated	14.9	0.1
ESSFwvp	Fescue Lichen	FC	Drier Herb	2.4	<0.1
ICHvc	HwBl - Devil's club	HD	Mesic Forest	1,550.3	11.2
ICHvc	ActSx - Dogwood	CD	Floodplain Forest	981.9	7.1
ICHvc	Sx - Devil's club	SD	Moist Forest	846.4	6.1
ICHvc	Deciduous Shrub	51	Wetter Shrub/Herb	752.8	5.4
ICHvc	Sx - Devil's club - Dogwood	DD	Floodplain Forest	577.5	4.2
ICHvc	River	RI	Non-vegetated	395.0	2.9
ICHvc	Hw - Step moss	HM	Drier Forest	312.5	2.3
ICHvc	Sx - Horsetail	SH	Wetland Forest	130.1	0.9
ICHvc	Gravel Bar	GB	Sparsely vegetated	122.2	0.9
ICHvc	$Mountain alder – Lady fern	52	Wetland Shrub/Herb	116.8	0.8

(continued)

Table 7.1-7. Terrestrial Ecosystems Mapped within the Access Road Sub-area (completed)

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of Access Road
ICHvc	Exposed Soil	ES	Sparsely vegetated	108.7	0.8
ICHvc	Lake	LA	Non-vegetated	92.7	0.7
ICHvc	Rock Outcrop	RO	Sparsely vegetated	38.8	0.3
ICHvc		Fm03		32.4	0.2
ICHvc	Herb Wetland (undescribed)	WH	Wetland Shrub/Herb	29.9	0.2
ICHvc	Willow Thicket	WT	Wetter Shrub/Herb	29.1	0.2
ICHvc	Shallow Open Water	OW	Non-vegetated	20.7	0.1
ICHvc	Shrub Wetland (undescribed)	WS	Wetland Shrub/Herb	20.6	0.1
ICHvc	Road Surface	RZ	Non-vegetated	17.6	0.1
ICHvc	Talus	TA	Sparsely vegetated	4.9	<0.1
MHmm2	HmBa - Blueberry	MB	Mesic Forest	2.1	<0.1
MHmm2	Deciduous Shrub	51	Wetter Shrub/Herb	1.2	<0.1
MHmm2	HmBa - Bramble	AB	Moist Forest	0.8	<0.1
MHmm2	BaHm - Twistedstalk	MT	Moist Forest	0.2	<0.1
MHmm2	Rock Outcrop	RO	Sparsely vegetated	0.0	0.0
MHmm2	Moraine	MN	Sparsely vegetated	0.0	0.0
MHmmp2	Rock Outcrop	RO	Sparsely vegetated	0.0	0.0
Total				**13,834.1**	**100**

While often occurring in blankets greater than one meter deep, veneers of less than one meter become more common approaching the height of land. This reduction in till depth corresponds with increasing elevation. Exposed bedrock and fen wetlands (Plate 7.1-9) also become common. Fen wetlands typically have accumulations of fibric peat derived from sedge inputs, and occurred in flat or gently sloping seepage (moisture-receiving) landscape positions where saturation of the rooting zone excludes the development of ericaceous shrubs (besides *Salix* and *Betula* species). Often the horizons are cumulic, as evidenced by the deposition of fine-textured mineral material between organic layers (evidence of low energy flood events). The depth of the organic layer is usually less than 60 cm, a result of the limited amount of inputs available on an annual basis due to the extreme climate, local edaphic conditions such as saturation of the soil profile during the growing season, and recent glacial history.

After traversing the height of land which is generally in the area just east of Todedada Wetland, the exploration access road turns south to Bowser Lake. This area is associated with a deepening of tills, and an associated increase in productive forest (Plate 7.1-10). Ecosystems are zonal and wetter sites series of ICHvc and ESSFun, with the ICHvc subzone occupying the lower valley position. The ICHvc and ESSFun (mapped as ESSFwv) subzones occupy approximately 90% of the Access Road Sub-area; mesic and moist forest ecosystems account for nearly one-third of this area. Most of these forests are mature and old, being classified as structural stages 6 and 7a, respectively. The forests mapped as structural stage 7a meet the age requirements of old forest (> 250 years old), but do not necessarily have the complex structure often associated with old growth, such as snags, large amounts of coarse woody debris in various stages of decomposition, and complex light regime. Exceptions to this include areas that were harvested in the 1980's within the vicinity of Highway 37, and areas of natural disturbance, including wildfire and flooding. Upland ecosystems within the ICHvc subzone are almost all zonal or wetter. These are characterized by a thick cover of hybrid white spruce and Western hemlock, with subalpine fir becoming more dominant at the higher elevations and in areas where cold air pools and persists.

Plate 7.1-9. Herbaceous fen, close to the maximum elevation of the exploration access road, just east of Todedada Wetland, Plot V070.

Plate 7.1-10. Productive forests found on the exploration access road between Todedada Wetland and Bowser Lake.

Subalpine fir is dominant within the floodplain ecosystems of the ICHvc, along with black cottonwood; some hybrid spruce is also present. These occur in elevated islands within braided stream systems; these are very common in in the Bowser River Delta, between Bowser and Knipple Lakes. The ESSFun (mapped as ESSFwv) occupies elevations above the ICHvc subzone and is recognized by the lack of Western hemlock and the dominance of subalpine fir in the tree layer, and a less vigorous shrub understory. As elevation increases, so does snow depth and persistence; this results in a mosaic of seepage ecosystems; herb meadows occur in positions within a matrix of forest, where continual seepage persists during the growing season. This maintains hygric soils throughout the growing season, allowing for the vigorous growth of herbaceous communities and the exclusion of conifers. They most commonly occupy the concave terrain associated with lower slopes. The soils are often mottled or gleyed, with a thin veneer of fine textured material due to the surface erosion of upslope non-vegetated soil. Sitka valerian (*Valeriana sitchensis*), Indian hellebore (*Veratrum viride*), and arctic lupine (*Lupinus arcticus*) are all typical plant species within these ecosystems. White mountain-heather (*Cassiope mertensiana*) is found on drier sites.

The road descends to the Bowser Lake Delta where an abundance of flood and early seral ecosystems are growing on fluvial deposits. Much of the material within this valley is probably associated with the bursting of the Tide Lake ice dam. In 1931, the ice dam was breached for the last time due to thinning of the glacier and the lake emptied. Heavily silted water scoured the Bowser Valley and flowed down the Nass to Observatory Inlet. Bowser River and Betty Creek now flow across what was once the lake bed and have incised channels up to 30 m deep in the sediments left by the proglacial lake (Clague and Mathews 1992). The parent materials are dominated by coarse textured fluvial sediments from the Tide Lake floods, overtopped with accumulations of modern alluvium. The Bowser Lake outflow itself is an impressive collection of braided streams. Flood ecosystems include low, medium and high bench floodplain ecosystems (Plate 7.1-11). Low bench ecosystems are often dominated by *Salix* spp., including *Salix commutata* and *Salix barclayii*. Medium and high bench ecosystems are submesic to xeric, with these edaphic soil conditions emphasized by dry vegetation indicator species such as *Dryas drummondii*, *Shepherdia canadensis*, and various lichens species.

Plate 7.1-11. Aerial photograph of high energy tributary entering the Bowser River from the south.

The delta somewhat narrows to the west, towards Knipple Lake (Plate 7.1-12). The road corridor continues along the high bench floodplain, bounded by steep colluvial slopes on the north and the outflow on the south; the delta itself is confined by glacially scoured hummocky exposed bedrock until Knipple Lake, where the Bowser River turns sharply south. Forested ecosystems are less common in this area, as the landscape is recently deglaciated, soils are often either thin or absent, and the edaphic effects of the existing glaciers reduce the length of the growing season.

Plate 7.1-12. Knipple Lake with the Knipple Glacier in the background, view to the north.

Terrain and Ecosystems of the TLSO Sub-Area

Tables 7.1-8 and 7.1-9 depict the surficial materials and terrestrial ecosystems, respectively, mapped within the TLSO Sub-area.

Table 7.1-8. Surficial Materials Mapped within the TLSO Sub-area

Surficial Material[1]	Map Code	Area (ha)	% of TLSO	% of LSA
Colluvium	C	3,172.7	24.5	10.0
Moraine	M	2,975.3	22.9	9.3
Ice	I	2,768.7	21.3	8.7
Rock	R	1,788.8	13.8	5.6
Fluvial; active	FA	524.3	4.0	1.6
Weathered Bedrock	D	431.5	3.3	1.4
Glaciofluvial	FG	415.8	3.2	1.3
Water Features	various	394.1	3.0	1.2
Glaciolacustrine	LG	270.5	2.1	0.8
Fluvial	F	108.7	0.8	0.3
Anthropogenic	A	56.6	0.4	0.2
Unclassified	(blank)	55.0	0.4	0.2
Organic	O	10.0	0.1	<0.1
Total		**12,972.1**	**100%**	**41%**

[1] *Based on leading surficial material decile*

Table 7.1-9. Terrestrial Ecosystems Mapped within the TLSO Sub-area

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of TLSO
BAFAun	Talus	TA	Sparsely Vegetated	1.2	<0.1
BAFAun	Rock Outcrop	RO	Sparsely Vegetated	0.9	<0.1
BAFAun	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	0.7	<0.1
BAFAun	Fescue Lichen	FC	Drier Herb	0.4	<0.1
BAFAun	Cliff	CL	Sparsely Vegetated	0.3	<0.1
CMAun	Glacier	GL	Non-vegetated	2,672.4	21.0
CMAun	Rock Outcrop	RO	Sparsely Vegetated	307.3	2.4
CMAun	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	267.9	2.1
CMAun	Moraine	MN	Sparsely Vegetated	261.3	2.1
CMAun	Exposed Soil	ES	Sparsely Vegetated	39.3	0.3
CMAun	Krummholz	KH	Parkland Forest/Krummholz	39.1	0.3
CMAun	Talus	TA	Sparsely Vegetated	25.4	0.2
CMAun	Herb Meadow	AM	Mesic Herb	7.9	0.1
CMAun	Permanent Snow/Ice	PN	Non-vegetated	5.7	<0.1
ESSFwv	Bl - Devil's club - Lady fern	FD	Wetter Forest	21.4	0.2
ESSFwv	River	RI	Non-vegetated	18.5	0.1
ESSFwv	Rock Outcrop	RO	Sparsely Vegetated	0.0	0.0
ESSFwv	BlPl - Cladonia	LC	Drier Forest	0.0	0.0
ESSFwv	BlHm - Azalea	FA	Mesic Forest	0.0	0.0
ESSFwv	Talus	TA	Sparsely Vegetated	0.0	0.0
ESSFwv	Willow Thicket	WT	Wetter Shrub/Herb	0.0	0.0
ESSFwv	Cryptogam - Altai Fescue	CG	Drier Herb	0.0	0.0
ESSFwvp	Moraine	MN	Sparsely Vegetated	45.0	0.4
ESSFwvp	Talus	TA	Sparsely Vegetated	14.1	0.1
ESSFwvp	Fescue Lichen	FC	Drier Herb	0.9	<0.1
ESSFwvp	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	0.9	<0.1
ESSFwvp	Rock Outcrop	RO	Sparsely Vegetated	0.4	<0.1
ESSFwvp	Willow Thicket	WT	Wetter Shrub/Herb	0.1	<0.1
MHmm1	HmBa - Blueberry	MB	Mesic Forest	516.2	4.1
MHmm1	Glacier	GL	Non-vegetated	163.4	1.3
MHmm1	Rock Outcrop	RO	Sparsely Vegetated	149.6	1.2
MHmm1	Moraine	MN	Sparsely Vegetated	112.9	0.9
MHmm1	Alder Thicket	AT	Deciduous Shrub	107.7	0.8
MHmm1	BaHm - Oak fern	MO	Mesic Forest	74.1	0.6
MHmm1	HmBa - Mountain-heather	MM	Drier Forest	66.4	0.5
MHmm1	BaHm - Twistedstalk	MT	Moist Forest	58.0	0.5
MHmm1	Exposed Soil	ES	Sparsely Vegetated	52.3	0.4
MHmm1	Talus	TA	Sparsely Vegetated	38.8	0.3

(continued)

Table 7.1-9. Terrestrial Ecosystems Mapped within the TLSO Sub-area (continued)

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of TLSO
MHmm1	Road Surface	RZ	Non-vegetated	36.9	0.3
MHmm1	Deciduous Shrub	51	Wetter Shrub/Herb	33.3	0.3
MHmm1	River	RI	Non-vegetated	33.2	0.3
MHmm1	Herb Meadow	AM	Mesic Herb	28.1	0.2
MHmm1	Pond	PD	Non-vegetated	19.0	0.1
MHmm1	HmYc - Deer cabbage	MD	Wetter Forest	15.0	0.1
MHmm1	YcHm - Skunk cabbage	YC	Wetland Forest	13.0	0.1
MHmm1	Krummholz	KH	Parkland Forest/Krummholz	13.0	0.1
MHmm1	Non-forested Wetland	WE	Wetland Shrub/Herb	9.1	0.1
MHmm1	Parkland Forest	PK	Parkland Forest/Krummholz	8.6	0.1
MHmm1	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	6.8	0.1
MHmm1	YcHm - Hellebore	YH	Wetter Forest	3.9	0.0
MHmm1	Gravel Bar	GB	Sparsely Vegetated	3.7	0.0
MHmm2	HmBa - Blueberry	MB	Mesic Forest	911.9	7.2
MHmm2	Rock Outcrop	RO	Sparsely Vegetated	438.3	3.5
MHmm2	HmBa - Mountain-heather	MM	Drier Forest	374.1	2.9
MHmm2	Alder Thicket	AT	Deciduous Shrub	359.0	2.8
MHmm2	Deciduous Shrub	51	Wetter Shrub/Herb	320.1	2.5
MHmm2	Exposed Soil	ES	Sparsely Vegetated	294.0	2.3
MHmm2	Moraine	MN	Sparsely Vegetated	256.6	2.0
MHmm2	Lake	LA	Non-vegetated	250.9	2.0
MHmm2	Dryas	DH	Drier Herb	175.7	1.4
MHmm2	BaHm - Twistedstalk	MT	Moist Forest	152.1	1.2
MHmm2	River	RI	Non-vegetated	147.5	1.2
MHmm2	Krummholz	KH	Parkland Forest/Krummholz	131.2	1.0
MHmm2	Talus	TA	Sparsely Vegetated	65.5	0.5
MHmm2	YcHm - Hellebore	YH	Wetter Forest	50.6	0.4
MHmm2	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	42.4	0.3
MHmm2	Glacier	GL	Non-vegetated	40.8	0.3
MHmm2	Willow Thicket	WT	Wetter Shrub/Herb	34.9	0.3
MHmm2	Herb Meadow	AM	Mesic Herb	27.9	0.2
MHmm2	HmBa - Bramble	AB	Moist Forest	21.7	0.2
MHmm2	Non-forested Wetland	WE	Wetland Shrub/Herb	17.7	0.1
MHmm2	BaHm - Oak fern	MO	Mesic Forest	12.3	0.1
MHmm2	Road Surface	RZ	Non-vegetated	9.9	0.1
MHmm2	Pond	PD	Non-vegetated	5.6	0.0
MHmm2	Parkland Forest	PK	Parkland Forest/Krummholz	4.7	0.0
MHmm2	Non-forested Wetland	31	Wetland Shrub/Herb	3.1	0.0

(continued)

Table 7.1-9. Terrestrial Ecosystems Mapped within the TLSO Sub-area (completed)

BEC Unit	Ecosystem Name	Map Code	General Ecosystem Type	Area (ha)	% of TLSO
MHmm2	Gravel Bar	GB	Sparsely Vegetated	1.6	0.0
MHmm2	HmYc - Deer cabbage	MD	Wetter Forest	1.3	0.0
MHmm2	YcHm - Skunk cabbage	YC	Wetland Forest	0.8	0.0
MHmmp	Krummholz	KH	Parkland Forest/Krummholz	645.5	5.1
MHmmp	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	618.5	4.9
MHmmp	Parkland Forest	PK	Parkland Forest/Krummholz	482.8	3.8
MHmmp	Moraine	MN	Sparsely Vegetated	384.2	3.0
MHmmp	Rock Outcrop	RO	Sparsely Vegetated	377.8	3.0
MHmmp	Exposed Soil	ES	Sparsely Vegetated	299.1	2.4
MHmmp	Herb Meadow	AM	Mesic Herb	136.7	1.1
MHmmp	Glacier	GL	Non-vegetated	122.6	1.0
MHmmp	Talus	TA	Sparsely Vegetated	98.3	0.8
MHmmp	Deciduous Shrub	51	Wetter Shrub/Herb	36.1	0.3
MHmmp	Road Surface	RZ	Non-vegetated	31.6	0.2
MHmmp	Pond	PD	Non-vegetated	9.4	0.1
MHmmp	Alder Thicket	AT	Deciduous Shrub	5.6	0.0
MHmmp	Permanent Snow/Ice	PN	Non-vegetated	4.2	0.0
MHmmp	HmBa - Mountain-heather	MM	Drier Forest	1.6	0.0
Total				**12,699.8**	**100.0**

This Sub-area starts near the Premier Mine site and travels approximately 53 km to the top of the Knipple Glacier. The southern reaches are comprised of shallow colluvial veneers over bedrock. Slopes are very steep, often exceeding 60%. Ecosystems in this area, although mapped as MHmm1, are transitional to the CWHwm subzone (which occurs in lower elevation valleys to the south of the LSA), based on the prominence of western hemlock in the main tree canopy. In addition, for the CWHwm transition area, there is a marked and observable difference between site series, as indicated by variations in plant assemblages (Plates 7.1-13 and 7.1-14). While site series have been established for the MH subzones, ecological variability due to variations in edaphic conditions are generally not as reflected in vegetation as they are in other zones. This is due to the current vegetation community (and ecological trajectory) being determined to a large extent by excessive snowpack, cold wet soils that persist throughout the growing season, and thick mor humus forms that are present across edatopes.

As the corridor proceeds north, the characteristics of the MHmm1 become more pronounced (Plate 7.1-15). Western hemlock becomes a minor component of the vegetation community, eventually dropping altogether to be replaced by mountain hemlock. The understory becomes less vigorous and diverse as the climate becomes colder and wetter. Soils become thin veneers over bedrock, while the most productive forests occupy steep mid slope positions that allow for soils to drain freely, reducing the productivity-dampening effect associated with saturated rooting zones. As the corridor approaches the Salmon Glacier, the transition from the MHmm1 to the MHmmp is apparent. Tree island ecosystems (Plate 7.1-16) become more and more common, scattered throughout mountain-heather and herb meadow communities. Tree islands occupy microtopography where edaphic conditions allow for the establishment of tree cover. This can include areas sheltered from prevailing wind so that desiccation is minimized, boulder fields that provide shelter for seed germination, and convex topographies that shed excess water. Reflecting the transition to an interior climate, tree species are dominated by *Abies lasiocarpa* (Subalpine fir), although

mountain hemlock was found to a limited extent. Ericaceous shrubs include bog blueberry (*Vaccinium uliginosum*), black huckleberry (*Vaccinium membranaceum)*, and oval leaf blueberry (*Vaccinium ovalifolium*), while partridge foot (*Luetkea pectinata*) is dominant where soils are either thin or absent.

*Plate 7.1-13. CWHwm 08 site series, as observed at Plot BJ033. This site is characterized by a vigorous understory, dominance of western hemlock, and the presence of skunk cabbage (*Lysichiton americanum*).*

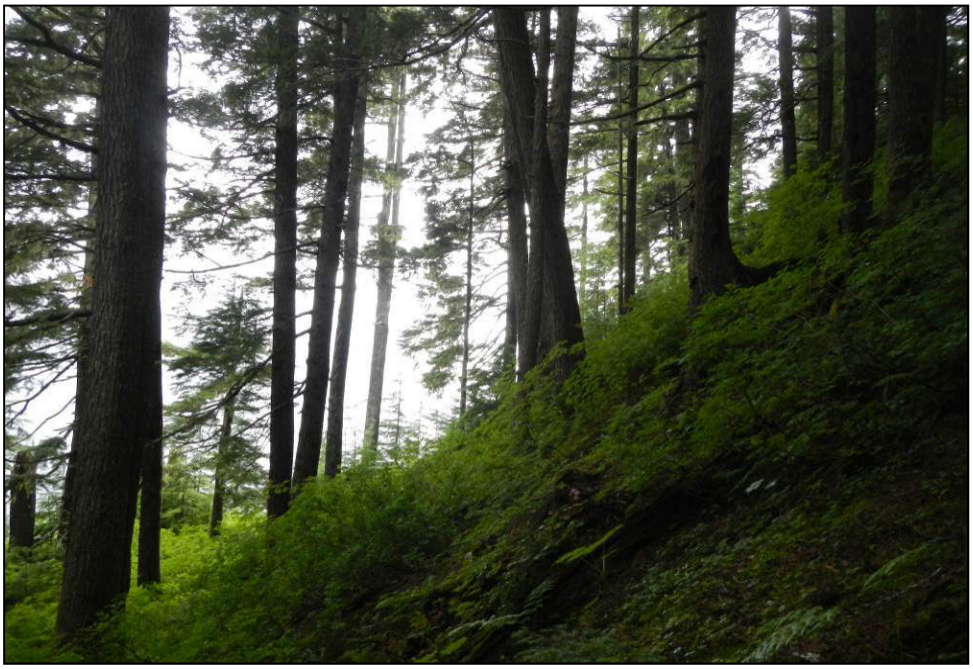

Plate 7.1-14. Zonal forests of the CWHwm subzone, along the south end of the Transmission Line – South Option (Plot 08-9410).

Plate 7.1-15. Zonal Forests of the MHmm1, are characterized by the dominance of Mountain hemlock, a midslope position, and sparse understory (Plot 08-9410).

Plate 7.1-16. An example of the MHmmp, at site BJ003, near the Salmon Glacier.

The MHmmp (Plate 7.1-17) persists for the entire length of the corridor, until it transitions to the MHmm2 ten kilometers south of Knipple Lake. Primarily, however, this is a distinction mapped using climate data, and describes in theory what vegetated ecosystems could be present given local climate characteristics. On the ground, the localized climatic effects imposed by the presence of glaciers and the physical impacts recent deglaciation has had upon the environment overrides ecological seral trajectory. Recent deglaciation and periglacial processes, as well as large scale disturbances such as the draining of Tide Lake, have resulted in a mosaic of alpine-like vegetation communities, tree islands, scoured rock and exposed terraces, similar to those found in the MHmmp.

Plate 7.1-17. MHmmp ecosystems, east of Granduc, at Plot V005.

Also present on areas of recent disturbance, such as glacial fluvial and fluvial terraces, are pioneer seral *Salix* and *Dryas drummondii* mat communities (Plate 7.1-18). Seral *Salix* describes very early seral ecosystems that develop on hydrologically mesic soils with little to no soil profile development. These occur on fresh moraine mounds, newly deposited glaciofluvial material and colluvium. Vegetative cover is scattered, but exceeds 10% so that the Barren classification does not apply. Plant species present are variable, but always include early colonization *Salix* species.

The *Dryas drummondii* mat vegetation association is an early seral association that is found in areas containing fresh parent materials coarse enough that moisture deficits persist throughout the growing season. They are most commonly found on low bench floodplains of medium to large rivers, where coarse gravels and cobbles are deposited cumulatively, or on recently deposited moraine with high coarse fragment content (Plates 7.1-19 and 7.1-20). They are dominated by *Dryas drummondii* with scattered amounts of *Alnus crispa, Shepherdia canadensis*, and a variety of *Salix* species.

*Plate 7.1-18. Typical Drummond's mountain avens (*Dryas drummondii*) vegetation community, located five km south of Knipple Lake, Plot V101.*

Plate 7.1-19. Variety of non-vegetated and early seral ecosystems along the Bowser River between Knipple Lake and Granduc. The white band of material within the sediments indicates the presence of past glacial lakes in the area.

Plate 7.1-20. Glaciofluvial terraces along the Bowser River, 15 km south of Knipple Lake.

7.2 SOILS MAPPING AND CLASSIFICATION

Soil formation in the LSA is limited by the cold climate and natural disturbance. Biological and chemical soil forming processes that are dependent on soil temperature thresholds can only be carried out during a brief seasonal window, while steep slopes limit pedogenesis due to constant downslope movement through soil creep, surface erosion, and mass movement. Soils that develop in colluvial and morainal surficial materials dominate the LSA; soils derived from fluvial, glaciofluvial, and organic deposits are less common. The dominant mineral soils in the LSA are weakly developed, and include Brunisols and Regosols. Other, less common mineral soils are Podzols and poorly drained Gleysols. The Organic soils, found in valley bottoms and depressional areas are very poorly drained and very sensitive to disturbance. They include poorly decomposed Fibrisols and moderately decomposed Mesisols of varying thickness.

7.2.1 Soil Mapping Units

A total of eight soil mapsheets were developed for the LSA, and are distributed as follows:

- three for the eastern segment of the exploration access road, from Highway 37 west to Knipple Lake (approximately 55 km);
- four for the Transmission Line – South Option, from the Long Lake substation north to Knipple Lake and extending to the eastern edge of the watershed boundary for Brucejack Lake, near the exploration access road km 70 (approximately 51 km); and
- one for the mine area and a minor portion of the mine access corridor shared by both the exploration road and the Transmission Line - South Option.

Project soil maps have been developed using ArcMap 10.1 to combine the following thematic maps and inspection site data:

- Project Terrain Mapping (TM);
- Project Terrestrial Ecosystem Mapping (TEM) — site series map including BEC zonation;
- Project Wetland Mapping (WM);
- slope gradient class mapping; and
- inspection site information (soil, TEM and wetland sites).

The approximately 1000 soil polygons delineated on the soil map are based on the TEM line work. The relationship between soil moisture regime and soil development (related to soil order classification) was derived from a combination of:

- Project soil (mineral soils) and wetland (primarily organic soils) inspection data;
- field guide landscape relationships for the LSA forest region (Banner et al. 1993); and
- Biophysical Soil Landscapes Inventory of the Stikine-Iskut Area (Fenger and Kowall 1992).

Individual Soil Map Units (SMUs) are defined by a combination of attributes, including soil climate, parent material (terrain surficial material), drainage (as derived from soil moisture regime (SMR)), probable soil development to the CSSC order level of classification (CSWG 1998). Each soil inspection site is assigned an SMU designation, based on these attributes. Characterization of SMU soil properties including horizon type and depths, texture, coarse fragment content, basic chemistry are derived from the field soil inspection and sampling sites and wetland inspection site data (see Appendix 7, Table A-1; Table A-2, respectively).

The most general level of soil landscape differentiation is soil climate, which was derived from 2012 BEC mapping. The eight subzones (Table 7.2-1) common to the LSA were grouped into two general soil climates: forested — including subzones considered capable of supporting continuous forest cover, and alpine — including the higher elevation, very cold parkland and alpine subzones, not capable of supporting continuous forest cover. Alpine processes may impact soil profile development through turbation and organic matter accumulation in the surface horizons not found in the forested zone. For mapping purposes, BEC zone boundaries are indicated on the soil maps and are not part of the SMU symbol.

Table 7.2-1. Generalized Soil Climate Groups in the Brucejack LSA

Soil Climate Group	BEC (2012) Subzone	Soil Climate Group	BEC (2012) Subzone
Forested	ICHvc	Alpine	ESSFunp
	ESSFun		MHmmp
	MHmm1		BAFAun
	MHmm2		CMAun

The primary attribute in defining SMU is the terrain surficial material. The secondary attribute is SMR, a proxy for soil drainage, and is derived from the TEM site series data. SMR has a strong influence on soil horizon development and is one of the principal parameters used in defining probable soil order classification for each SMU, within each soil polygon, based on the soil development/landscape relationships discussed above.

Interpretations of the 77 site series presented in the preliminary TEM legend (presented in Appendix 6) provide information on soil moisture regime ranges from which typical SMR values are assumed. Some site series also provided information on soil parent material as well as non-soil features, such as water features. TEM site series developed for the LSA are based, in part, on concepts included in the Prince Rupert Forest Region Field Guide (Banner et al. 1993). The SMR data from the TEM were used to reflect soil drainage for the soil polygons. The SMR is divided into eight classes with an SMR of 0 representing very dry sites, which are interpreted as rapidly drained, and an SMR of 7 representing very wet sites, which are interpreted as very poorly drained (Table 7.2-2).

Table 7.2-2. Soil Moisture Regime and Soil Drainage Class

Soil Moisture Regime (SMR)		Soil Drainage Class	
ID	**Descriptor**	**ID**	**Descriptor**
0	Very xeric	X-W	Very rapid to well
1	Xeric		
2	Subxeric		
3	Submesic		
4	Mesic	M	Moderately well
5	Subhygric	I	Imperfect
6	Hygric	P	Poor
7	Subhydric	V	Very poor

The soil maps were developed based on interpretation of the site information, the slope gradient, surficial materials, slope position, site drainage and drainage inferred from site position and slope, coarse fragment content, soil texture, soil depth, and soil classification. These are presented in Appendix 7. An overview map is presented in Figure 2-1.

An open legend was used to describe the attributes of the SMUs for each polygon on the soil map. The resulting SMUs for each polygon have unique properties presented as labels for each polygon. The label includes a polygon number, the surficial material type, soil drainage (as interpreted by SMR), and soil order, with some subgroup information where considered relevant to further interpretation. Soil phase information is provided for SMUs which are shallow to bedrock and/or affected by active geomorphic processes. Slope attributes for each numbered soil polygon is presented separately, on the slope gradient class map. General comments on typical slope attributes (slope class) for the various SMUs are presented in the Generalized Soil Legend, described in Section 7.2.2.1.

Each soil map includes the following:

- colour coded polygons reflecting the primary surficial material within each polygon;
- soil site and sampling locations;
- TEM and Wetland inspection locations;
- 20 m contours;
- BEC (2012) sub zone boundaries; and
- polygon labels that includes polygon number ID, primary SMU and phase qualifiers for depth to bedrock, and geomorphic activity.

Depth to bedrock is assumed to be within 1m for all units designated by surficial material R or D. For all other surficial materials an 'r' qualifier is added where the material thickness is potentially less than one metre to bedrock (terrain surface expression 'x' and or 'v' with subsurface material R). In addition, there are a number of active geomorphological processes having direct impact on soil development and/or potential land use. Within the corridor study area, these commonly include:

- (A) snow avalanches — common to polygons with colluvial (C) and morainal (M) surficial materials;
- (B, E, J, I) — floodplain processes;
- (L) seepage — common to polygons with C and M materials;
- (U) inundation — common to polygons with fluvial (F) and organic (O) materials;
- (V) gully erosion — common to polygons with C, bedrock (R), and M surficial materials;
- (R) rapid mass movement (debris flow, debris slide, rockfall) — common to polygons with C, R, and M materials, though may include fans shaped areas of both C and F origin); and
- (Z) periglacial processes (may include cryoturbation, nivation and solifluction, C, N, S) — common to the 'Alpine' soil climate zone.

Where applicable, a generalized geo-process notation (*) is provided on the appropriate soil polygons on the soil maps. Specific geo-process information (process class and subclass) is included with the terrain mapping (Appendix 5).

7.2.2 Soil Potential for Use in Reclamation Assessment

The suitability of soils for salvage and reclamation is evaluated based upon the characteristics of the soils that comprise the SMUs. The evaluation of soil suitability is based on the analyses of several physical and chemical characteristics, as presented in Table 7.2-3.

Table 7.2-3. Criteria for Evaluating Suitability of Soil for Use in Reclamation

Limitation\Property	Good (G)	Fair (F)	Poor (P)	Unsuitable (U)
Reaction (pH)	5.0 to 6.5	4.0 to < 5.0 or > 6.5 – 7.5	3.5 to < 4.0 or > 7.5 to 9.0	< 3.5 and > 9.0
Salinity (EC; dS\m)	< 2	2 to 4	4 to 8	> 8
Sodicity (SAR)	< 4	4 to 8	8 to 12	> 12
Available Water Storage Capacity 'AWSC' (mm\cm\50 cm)	> 45	25 to 44	10 to 24	< 10
Saturation %	30 to 60	20 to < 30, > 60 to 80	15 to <20, > 80 to 100	< 15, and > 100
% Coarse Fragments (+2 mm size fraction)	< 50	50 to 70	> 70 to 90	> 90
Texture	SL, L, SiL	LS, CL, SCL, SiCL	S, SiC, Si, C, HC	Consolidated bedrock
Consistence (moist)	very friable, friable	loose, firm	very firm; sticky (wet)	extremely firm
% Organic Carbon (Topsoil use 3 categories only); Subsoil (only considered limiting if > 17% C)	2 - 17 (topsoil)	1 to < 2 (topsoil), or, if > 17 (soil amendment only – topsoil and subsoil)	< 1 (topsoil)	Not limiting to this degree for either topsoil or subsoil
$CaCO_3$ Equivalent (%)	< 2	2 to 20	> 20 to 70	> 70

Shaded parameters not used as criteria in the current report as no supporting lab data to rate these parameters exists.

The assumption is that these materials will be used in the reconstruction of a soil profile, the root zone, in the development of upland habitat common to the LSA. The ratings reflect the proposed end land use involving re-vegetation to locally adapted, terrestrial native species. These ratings are exclusive of metals analyses and criteria such as provincial (CSR) and federal (CCME), discussed by others.

Table 7.2-3 is an iteration of a table that was originally developed for forest production and is a modification of "Criteria for evaluating the suitability of surface material (upper lift) for re-vegetation in the Eastern Slopes Region," (Macyk et al. 2004). Table 7.2-3 has different ratings for pH and coarse fragment content than the original table, to reflect local site conditions. Other criteria may apply if the soil material is to be used for other purposes such as pond liners or other capping/barrier material.

Materials rated Good, Fair, or Poor are considered suitable for use. The relative ratings imply that increasing management input may be required to achieve acceptable results using root zone media with these limitations. The shaded parameters were not measured but, under certain conditions, should be considered if further sampling/testing is to be undertaken.

All soil horizons will be rated based on available data, which in this report is primarily morphological. For comparative purposes, the soils from which samples were analyzed, were classified at the horizon level (sometimes representing more than one discreet horizon) and grouped according the order classification (CSSC 1998) and soil type (parent material and soil drainage).

The use of interpreted organic matter (carbon) content is somewhat complex since too little organic matter is considered moderately to severely limiting, whereas excess organic matter is also potentially problematic. The criteria is for use in the root zone and further differentiation is given to mineral material (defined as material with less than 17% organic carbon) that may be naturally enriched with organic carbon, and particularly suited for application at the surface (approximately the 0 to 30 cm) replacement layer. Organic soils, defined as soils with > 17% organic carbon, are often found as thick material (typically > 30 cm), typically located in poorly drained, bogs and fens.

Organic soils are considered potentially useful as amendments to organic-poor materials. They may also be a significant source of 'refugia' and used in direct replacement in constructed wetland areas, if the receptor areas are available at the time of disturbance. The organic LFH layers, typical of many upland forested soils, are generally thin (less than 10 cm thick) and provided an 'o' rating. These are considered to be suitable and assumed to be incorporated with the underlying mineral soils at the time of salvage. Upland organic soils (Folisols) were not observed in the field survey but may occur in the LSA based on studies by others (LHM 26 and Fenger et al).

7.2.2.1 Generalized Soil Legend

SMUs represent unique combinations of soil parent materials, soil moisture regime and soil development. SMUs are presented on the Soil Map. A total of nearly 100 combinations of SMUs were noted based on the mapping system used. Some are of very limited occurrence and or extent. A Generalized Soil Legend was developed to group SMUs with similar genesis and potential management issues (Table 7.2-4). The 22 soil groupings are based primarily on soil parent materials, soil development and drainage.

The range of individual SMUs, as presented on the Soil Map in Appendix 7, are included in each Soil Group in Table 7.2-4. For management and discussion purposes these SMUs are sorted into Soil Groups reflecting their general soil management issues such as reclamation potential, salvage depth and or suitability. Common landscape characteristics such as slope gradient and soil moisture, may impact soil handling operations, and are included in the following discussion.

Table 7.2-4. Generalized Soil Legend for the Brucejack Gold Mine Project

Soil Climate[1]	Soil Group	Drainage	SMU Range per Soil Map[2]	Soil Order Range[2]
Alpine, Forest	**Colluvial Soils — commonly occur in steep to very steep topography**			
	1	Very Rapid – Well	C1.B, C2.P, C3.B, C3.P	Brunisols (B), Podzols (P)
	2	Mod. Well - Imperfect	C4.B.so, C5.B, C5.B.g, C5.P, C5.P.g, U5.B.g	B, B.so, B.g, P, P.g
	3	Poor	C5.G, C6.G, C7.G	G
	4	Variable	C2.n, C2.R, C3.R, C6.R	n, R
Alpine	**Residual Soils — occur in variable, often hummocky to steep, topography**			
	5	Very Rapid -Well	D1.B, D3.B.so, D3.P	B, B.so, P
	6	Variable	D5.R.g, D6.B.g, D6.G, D1.n, D2.R	R, R.g, B.g, G, n
Forest	**Fluvial Soils — near level, commonly with terraces**			
	7	Variable	F '2.R, F '4.R, F '5.R, F4.R, F5.n, F6.R, F 'n.n, F5.R, Fn.n, G5.R; L1.n, L2.R	R, n
	8	Mod. Well - Imperfect	F '5.R.g, F '6.G, F '7.G, F5.B.g, F5.G, F5.R.g	R.g, G, B.g
	9	Rapid -Well	F5.B, F5.P	B, P
Forest	**Glacio-fluvial Soils — near level terraces to undulating topography**			
	10	Mod. Well - Imperfect	G5.B, G5.B.g, G5.P, G5.P.g	B, B.g, P, P.g
	11	Poor	F6.G, F6.R.g, F7.G, F7.G.p, G6.G, G7.G, G7.G.p, L6.G	G, R.g, G.p
Forest (Alpine)	**Morainal Soils — variable topography, commonly on complex, gentle to moderate slopes**			
	12	Rapid – Well	M1.P, M2.P, M3.B, M3.B.so, M3.P	P, B, B.so
	13	Mod. Well - Imperfect	M4.B.g, M4.B.so, M4.P, M4.P.so, M5.B, M5.B.g, M5.P, M5.P.g	B, B.g, B.so,P, P.so, P.g
	14	Poor	M5.G, M6.G, M6.P.g, M7.G, M7.G.p	G,P.g,G.p
	15	Rapid -Mod. Well	M2.n, M2.R, M4.n, M4.R	n, R
Forest (Alpine)	**Wetland / Organic Soils — simple, level to near level topography**			
	16	Very Poor	O7.O	O (M, F)
	17	Very Poor	O5.G.p, O6.G.p, O7.G.p	G.p
Alpine (Forest)	**Bedrock/Residual Soils — variable topography though commonly moderately steep to steep**			
	18	Variable	R1.R, R2.B, R2.R, R3.R, R4.B.so, R4.R, R5.B, R5.G, R5.R	R, B, B.so, G
	19	Restricted	R1.n,R2.n	n
	Non-Soils — variable topography			
Alpine, Forest	20	Not applicable	Wn.n - Water covered	n
Alpine	21	Not applicable	In.n - Ice and permanent snow	n
Alpine	22	Variable	An.R - anthropogenic (mine waste soils)	R, n

[1] Soil climates are defined as follows: Alpine - includes alpine and parkland BEC subzones (BAFAun, CMAun, ESSFunp, MHunp); Forest - includes forested subzones and variants (ICHvc, ESSFun, MHmm1, MHmm2)
[2] Soil Order Abbreviations: B - Brunisol, B.g -gleyed, B.so -sombric/turfy A; G - Gleysol, G.p -peaty; n - non-soils; O - organic orders (Mesisols and Fibrisols); R - Regosol, R.g -gleyed; P - Podzol, P.g - gleyed.

7.2.2.2 Soil Groups

The following briefly describes typical characteristics of each Soil Group.

Soil Group # 1 - 4: Colluvial Soils

Generally, soils derived from colluvium are high in coarse fragments, associated with steep slopes, and have discontinuous pedogenic processes due to continual downslope movement (which may be slow, rapid, continuous or discontinuous). They are most commonly derived from the failures of moraine deposits (such as along the Transmission Line – South Option) and rockfall (common along the exploration access road). These result in very different parent materials. Rockfall and talus colluvium has coarse and angular clasts, is unstable, and rapidly drained (Soil Group 4). Soil nutrient content is generally low, but can be high if the source rock type is high in base nutrients.

Moraine-derived colluvium has the characteristics of the source material, which is highly variable. Many of these slopes are active; as a result they have little to no vegetative cover. Herb meadows are associated with a distinct type of colluvium that is present in higher elevations in the ESSFunp. Fine textured colluvial veneers are often found at slope breaks. These form as a result of the washing of fine material out of the upslope deposits. Since the movement is gravity assisted, it is classified as colluvium and not fluvial. These deposits support ecosystems such as alpine herb meadows, which are maintained by the presence of water in the rooting zone throughout the growing season.

To describe the range of colluvial derived soils in the LSA four Soil Groups were established based on relative drainage and soil development, as follows:

- **Soil Group 1 —** includes well to rapidly drained, well developed soils, Dystric Brunisols and Ferro-Humic and Humo-Ferric Podzols. Above the treeline, it is common to have additional organic matter in the surface A horizon, leading to 'Sombric', Ah horizons in the Brunisolic soils. These are typically developed in upper and mid slope positions in coarse textured, material of high, coarse fragment 'CF' content (skeletal > 35% to 70% CF, to fragmental, > 70% CF).
- **Soil Group 2 —** includes moderately well to imperfectly drained, well developed soils, commonly seep affected, gleyed Brunisols and gleyed Podzols. These are typically developed in lower slope positions in variable to coarse textured, material of high, coarse fragment 'CF' content (skeletal > 35% to 70% CF, to fragmental, > 70% CF). Shallow cappings of medium textured, slightly lower CF content, may occur as a result of upslope surface washing or avalanche deposition (Plate 7.2-1).
- **Soil Group 3 —** includes poorly drained, Gleysolic soils. These are typically developed in lower to toe and depressional slope positions. Soils display a range of medium to coarse textures, in material of variable surface CF content.
- **Soil Group 4 —** includes all non-soils or very weakly developed Regosolic soils developed in a range of colluvial materials (some derived from recent rockfalls or actively failing, over steep, morainal deposits). Drainage may vary but is often well to rapid. These often occur in association with steep to very steep slopes and occur in a variety of slope positions (Plate 7.2-2).

Soil Group # 5 - 6: Residual Soils

Residual soils typically occur at high elevation and have a restricted growing season (alpine soil climate; Plate 7.2-3). The topography is often complex with an irregular occurrence of bedrock outcrops and soils that are characteristically shallow to very shallow. The surface horizons are often root bound and turfy (Plate 7.2-4). Some soils show moderate subsoil development (Brunisols), Soil Group 5; others showing weak development (Regosols) or signs of wetness (Gleysols), Soil Group 6.

Plate 7.2-1. A well developed, medium to coarse textured, non-gravelly to fragmental, colluvial SMU C4.B soil, Dystric Brunisol, typical of Soil Group 2, Site K045.

Plate 7.2-2. Very steep colluvial slopes (actively failing morainal materials, SMU C2.n) typical of Soil Group 4 (non-soils) and weakly developed Regosols (recent, stabilized, vegetated areas, SMU C2.R).

Plate 7.2-3. Complex, topography of shallow weathered soil and exposed bedrock, typical Soil Group 5, SMU D2.B, Site 12-7137 (BJ 013), in the Mine Site Sub-area.

Plate 7-2-4. A turfy, surface horizon and high coarse fragment content, sandy loam textured, typify this shallow, rapidly drained, very strong acidic, Dystric Brunisol soil, SMU D2.B (lithic phase), Soil Group 5, Site 12-7137.

Soil Group # 7 - 9: Fluvial Soils

Fluvial soils commonly occur in the valley bottoms on level to nearly level topography, usually in a series of terraces above the active channel. They often display a stratigraphically variable, though commonly very high, coarse fragment content and coarse soil textures (Plate 7.2-5). They display a range of soil moisture, depending on the often subtle, elevation differences above the fluctuating groundwater level. Soil Group 7 soils most commonly show no or very weak profile development (Orthic Regosols), often with evidence of past burial of the soil surface (Cumulic Regosols) by shifting channel deposits (Plate 7.2-6). The generally less well drained, weakly developed, Regosols and shallow, often gleyed, Brunisols comprise Soil Group 8 (Plate 7.2-7). The better developed soils (Soil Group 9) usually occur on the higher fluvial benches above the areas of frequent flooding (Plate 7.2-8).

Plate 7.2-5. High coarse fragment parent material associated with fluvial deposits.

Soil Group # 10 - 11: Glaciofluvial Soils

Glaciofluvial deposits are materials deposited by ice-contact rivers. Due to the high energy, high volume nature of these rivers, they tend to be poorly to moderately stratified and very coarse textured. Parent materials derived from these will usually have very rapid drainage and low nutrient content. Soil pedogenesis is very slow due to lack of fine textured material.

Soil Groups 10 and 11 commonly in valley bottoms and lower side slopes on elevated, often level to irregular terrain associated with the main creeks and river valleys. These soils display commonly high to very high coarse fragment content and coarse textures, in a range of soil moisture regimes. Rapidly to moderately well to imperfectly drained Regosols (BJ001), Brunisols and Podzols (Leach Site 1-3) typify Soil Group 10. A range of poorly drained, gleyed Regosol and Gleysol soils, that may include shallow, surface peat layers occur in lower and toe slope positions are associated with Soil Group 11.

Plates 7.2-9 and 7.2-10 shows rapidly to well drained, glacio-fluvial terrain with examples of recent, glacio-fluvial deposits, with soils displaying no significant profile development, Regosols (photo at left), and older, forested deposits with deep, well developed Podzols and Brunisols (Soil Group 10).

Plate 7.2-6. Very weakly developed, Orthic Regosol, soil profile, developed on a sandy, very gravelly, recent fluvial plain, typical of SMU F2.R, Soil Group 7, as seen at Site K058 (12-7020), Access Road Sub-area.

Plate 7.2-7. A very weakly developed, imperfectly drained, SMU F5.Rg, Gleyed Regosol, of Soil Group 8, developed on sandy to gravelly, at depth, fluvial plain (Site K049, near km 37, exploration access road).

Soil Group # 12 - 15: Morainal Soils

Morainal soils commonly occur on complex, gentle to moderate and steep terrain. They display a variable, though commonly high coarse fragment content, with a range of medium to coarse soil textures (Plate 7.2-11 and Plate 7.2-12). Soil development varies from very well developed, moderately deep, Podzols and Brunisols (Soil Group 12) to very weak or undeveloped, Regosols and non-soils, in areas of active de-glaciation (Soil Group 15). Soil drainage differences account for the soil development differences noted in seep affected, imperfectly drained Soil Group 13 soils (gleyed subgroups of Brunisols and Podzols; Plate 7.2-13), and poorly to very poorly drained, Gleysols, of Soil Group 14, commonly located in depressions or at toe slope positions (Plate 7.2-14).

Soil Group # 16 – 17: Wetland — Organic Soil

Organic soils occur on near level to depressional, poorly to very poorly drained terrain. These are located primarily in valley bottoms and the near level depressions in the hummocky terrain in the eastern segment of the exploration access road, near the Bell River (Highway 37). They also occur at the height of land near Todedada Wetland in wetlands fens (Plate 7.2-15). Soil Group 16 comprises of deep, > 1 m thick, mesic and fibric organic deposits (Typic and Terric Mesisols and Fibrisol soil). These are associated with Soil Group 17 shallower (< 1 m) peat deposits, including soils classed as Terric Fibrisols and Terric Mesisols and peaty phase (< 0.4 m peat) Gleysols. Soil Groups 16 and 17 are associated with terrain units Ob and Ov(x), respectively.

Plate 7.2-8. Moderately well developed, moderately well drained, SMU F4.B, Orthic and Eluviated Dystric Brunisols of Soil Group 9 (Site K031).

Plate 7.2-9. Glaciofluvial sediments showing little pedogenesis.

Plate 7.2-10. Overview of a glaciofluvial landscape.

Plate 7.2-11. Well drained, moderately deep, mixed Brunisolic and Podzolic soils developed on a veneer to blanket, of morainal material, typical of SMU M3.P (Soil Group 12), at Site K054, along the exploration access road (km 29).

Plate 7.2-12. Soil profile of a moderately deep, well drained, Eluviated Dystric Brunisol soil developed in morainal material, typical of SMU M3.B.

Plate 7.2-13. A forested, moderately well drained, very strongly acidic, Humo-Ferric Podzol soil developed on a veneer of morainal material shallow is typical of SMU M4.P, Soil Group 13 (Site 12-7167), Access Road Sub-area.

Plate 7.2-14. Site KG009, displays a shallow, poorly drained, gleysolic soil developed on 'washed' Cv/Mb, Site Series 51 (avalanche track with seepage) SMU M6.G, of Soil Group 14 (near the exploration access road km 6).

Plate 7.2-15. A near level, very poorly drained site, with a moderately thick, organic (peat) soil (Terric Fibrisol) typical of SMU O7.O, Soil Group 17, Site K023 (south of the exploration access road km 5).

Soil Group # 18 – 19: Bedrock

Exposed bedrock occurs in variable topography, most commonly ranging from steep to very steep in the forested soil climate zone to hummocky to very steep in the alpine soil climate zone. These Soil Groups represents primarily bedrock outcrops (> 50% of the surface is exposed, consolidated bedrock), but with pockets of shallow soil of variable soil moisture regimes. These are mostly very dry, with a turfy, mineral surface layer. Soil Group 18 is comparatively deeper lithic contact (generally less than 0.5 m) including a range of soil classes Regosols, Brunisols and, less commonly, Gleysols. Soil Group 19 is defined by a very shallow, lithic contact within 0.2 m and commonly includes soils too thin (< 10 cm) to be considered soil, as well as Orthic Regosols, which are commonly associated with exposed soil.

Residual soils units, Soil Groups 5 and 6, are differentiated by having less exposed, consolidated bedrock (< 50% cover) than Soil Groups 18 - 19. Folisols (shallow upland, organic soils), though not noted in the survey inspections, may be associated with bedrock and associated with inactive, talus slopes, and present in the wet, upper elevations of the forested soil climate zone.

Soil Groups # 20 - 22: Non-soils

These Soil Groups include three general landscape covers:

- # 20 — any, ordinarily water covered areas (i.e., lakes, ponds, river channels), occurring across all soil climate zones;
- # 21 — ice and permanent snow covered lands, located in the alpine and extreme upper elevations of the forested soil climate zone; and
- # 22 — anthropogenic materials defined as material altered by human activities.
- Groups 20 and 21 are shown in Plate 7-2-16.

Plate 7.2-16. Non-soils include areas of permanent water cover, like Brucejack Lake (included in Soil Group 20) and the out-flowing glacier, shown sloping left to right in the middle of the photo (Soil Group 21).

7.2.3 Soil Analytical Results

Soil samples were collected from 34 inspection sites (50 samples in total including duplicates) representing various soil parent materials from across the various soil climates in the LSA (Figure 7.2-1). Soil samples were not collected from wetland inspection sites, though in-situ water reaction (pH) data was collected. At all 34 sites samples were collected from the near surface, to reflect the zone of maximum soil development in the soil profile. At 12 sites, the less weathered, subsoil, in the same parent material (or overburden type) was collected. Topsoil samples were generally collected from a depth zone of 10 – 30 cm below the mineral surface (auger barrel or pit profile). Subsoil samples were centered on a depth of approximately 60 cm. Only one exception was noted, nominally 40 cm, at site 12-7167, where the occurrence of bedrock prevented deeper sampling. Duplicate samples were obtained from 3 sites. The sample code ID includes the site location name (per the inspection location map) and the approximate depth of sampling.

Soil results for the analyses used to characterize soil development and rate suitability for reclamation are presented in Table 7.2-5, Soil Suitability Characterization Analytical Results (non-metals). A summary of the specific site sampled, depth from which the soil was obtained and SMU that it represents is provided in Table 7.2-5. A discussion of the results of each soil parameter is presented in the following subsections, except for soil metals. Soil metals are discussed separately (Section 7.4.1).

7.2.3.1 Soil Reaction (pH)

The range of mineral soil pH found in soil in the LSA is relatively wide, displaying pH values of 3.8 (extremely acidic) to 8.1 (moderately alkaline). However, most topsoil samples commonly display extremely to strongly acidic reaction (pH < 4.5 to 5.5). Two sites, with less well developed or younger soils, display less acidic to mildly alkaline reaction, pH 6.4 to 7.6 (sites BJ-030, a young, Regosolic soil

developed on a glaciofluvial terrace, SMU G2.R; and site 12-7105 (sample ID 12-1705), a high elevation, Brunisolic soil, developed in a gently sloping, recent fluvio-colluvial fan, SMU C5.B.

Subsoil samples commonly display extremely to medium acidic reaction (pH < 4.5 to 6.0), though range to pH 8.1 (moderately alkaline). Compared to their overlying topsoil layers, the subsoil horizons are often relatively less acidic or approximately the same in reaction. Soil weathering (base leaching) associated with organic matter accumulation and organic acid production may account for this trend. The paired comparison of topsoil to subsoil generally shows slightly less acidic reaction (maximum 0.6 pH units higher as per site V030). One obvious exception to this trend is site 12-7137 (formerly BJ013), where the subsoil is 0.7 pH units lower than the overlying material (a weathered bedrock unit of previous exploration related disturbance — possibly a truncated 'soil' profile). The subsoil soil reaction suggests that many of the soil parent materials may be base poor, with the notable exception of the glaciofluvial site BJ030 and fluvial site 12-7105.

7.2.3.2 Free Carbonates

The common occurrence of an acidic soil reaction precluded the testing for free carbonates in all but a few soil samples. Testing for free carbonates was conducted on 11 samples, four from where soil reaction ranged from slightly acidic to moderately alkaline (two samples from the near surface layer and two from the subsoil) and seven, more acidic, subsoil samples to confirm the pH: free carbonate relationship at low pH.

Results of lab testing confirm the near total absence of free carbonates samples with a pH of 6.6 or less. The $CaCO_3$ Equivalence (inorganic carbon) was below detection on all but one sample in this pH range. The exception, a surface sample, BJ15-20cm (pH 5.27), displayed a very low $CaCO_3$ Equivalence, less than 1%. This soil developed in shallow to bedrock parent material in the alpine.

Two of the tested samples that had mildly to moderately alkaline reaction displayed moderately high $CaCO_3$ Equivalence, of 8 to 14%. These samples are from the same soil profile, one near surface (0 - 20 cm) the second at depth (to 60 cm). The profile represents a moderately well developed, alpine, turfy, Melanic Brunisol derived in a fluvio-colluvial fan deposit, SMU C5.B (Site 12-7105 sample 12-1705).

7.2.3.3 Soil Carbon

Organic matter accumulation in the soil profile is assessed by the measurement of the organic carbon content of the soil. In the absence of mineral carbon (typically found as carbonates), total carbon content is used as a proxy for organic carbon accumulation. A total of 35 of 50 possible samples were tested for total carbon. Organic matter/carbon content is one of the primary lab parameters used to indicate soil development.

Testing of total and organic carbon and free carbonates confirms that with the exception of soils displaying alkaline soil reaction, total carbon is a reasonable proxy for organic carbon in the local soils. The very few local soil samples displaying alkaline soil reaction may contain inorganic carbon. Caution in interpreting the results for organic carbon content are to be applied, as some of the total carbon is likely associated with the inorganic forms of carbon, possibly of bedrock source.

The median value of total carbon content (by combustion) for the 35 samples of local surface and subsoil is 3.4% and ranges from 0.4% (site BJ-30) to 21.3% (Site 12-7168). Organic wetland soils were generally not included in this sampling/testing program.

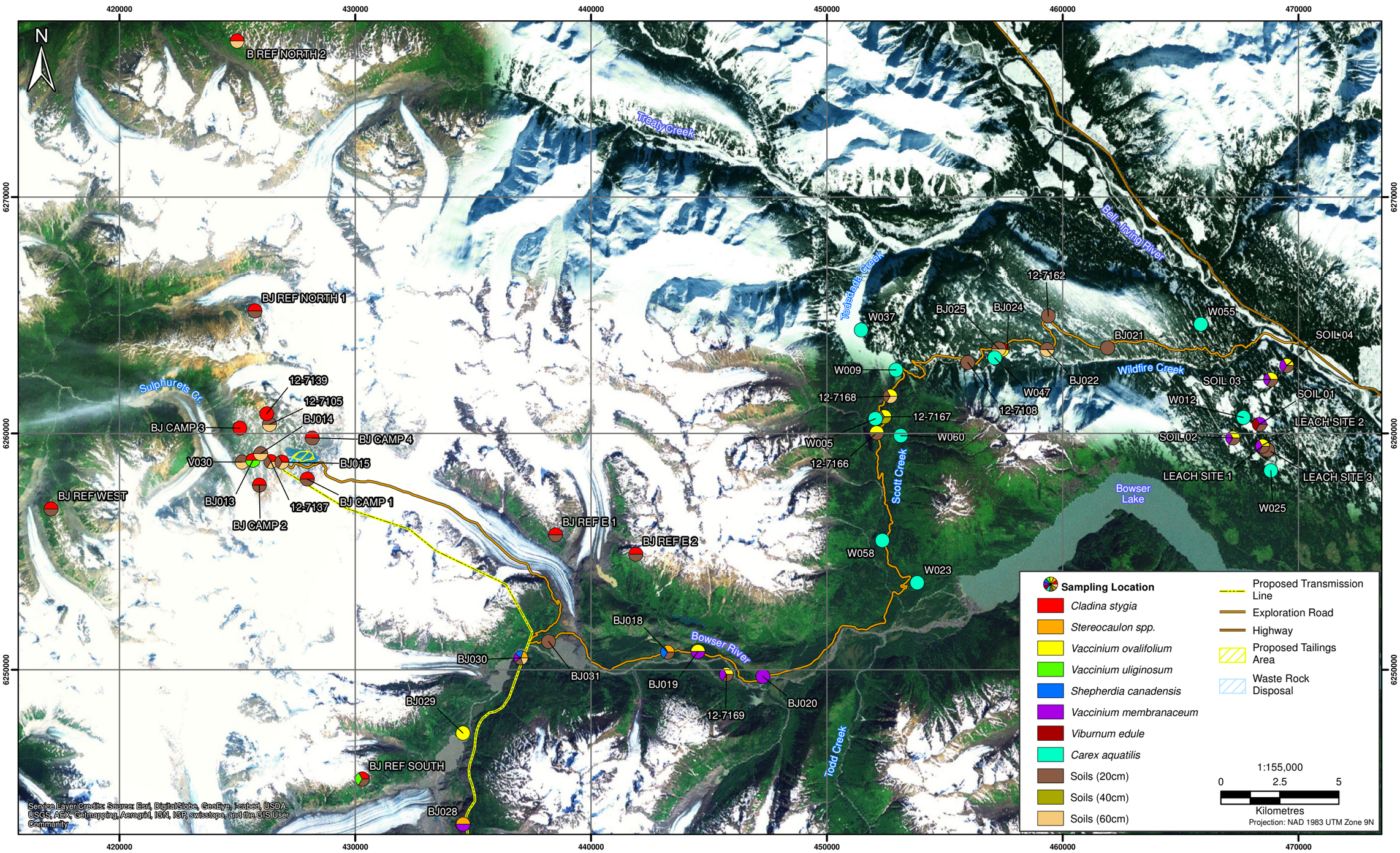

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Figure 7.2-1

Vegetation and Soil Sampling Locations for Metal Analyses

Table 7.2-5. Soil Suitability Characterization Analytical Results (Non-metals)

	Sample Depths (cm)				Physical Tests		Particle Size						Organic / Inorganic Carbon				Plant Available Nutrients						Saturated Paste Extractables	
Sample ID	20	40	60	ALS Sample ID	pH (1:2 soil:water)	pH Class	% Gravel (>2mm)	% Sand (2.0mm - 0.063mm)	% Silt (0.063mm - 4um)	% Clay (<4um)	ADJST % Clay (<4um)	Soil Texture	Texture-general Class	$CaCO_3$ Equivalent	Inorganic Carbon	Total Carbon by Combustion	Total Organic Carbon	Total Sulphur	Calcium (Ca)	Cation Exchange Capacity	Magnesium (Mg)	Potassium (K)	Sodium (Na)	ESP	ESP-Adj
12-7103-20CM	1			L1241433-1	5.63	4	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
12-7103-60CM			1	L1241433-2	5.89	4	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
BJ014-20CM	1			L1241433-3	4.77	2	5.32	47.8	38.2	8.67	9%	Sandy loam	4	-	-	5.9	-	-	-	37.7	-	-	-	-	
BJ014-60CM			1	L1241433-4	4.93	2	11.9	62.9	19.7	5.62	6%	Sandy loam	4	-	-	1.2	-	-	-	10.2	-	-	-	-	
12-7105-20CM	1			L1241433-5	7.56	7	36.9	46.6	13.3	3.30	5%	Loamy sand	5	8.21	0.98	3.3	2.33	1000	21.8	9.33	0.25	0.25	0.25	-	3%
12-7105-60CM			1	L1241433-6	8.08	8	-	-	-	-		-		14.4	1.73	3.1	1.36	-	-	-	-	-	-	-	
12-7169-20CM	1			L1241433-7	4.72	2	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
12-7166-20CM	1			L1241433-8	4.18	1	-	-	-	-		-		-	-	7.7	-	-	-	-	-	-	-	-	
BJ015-20CM	1			L1241433-9	5.27	3	16.0	35.8	34.9	13.3	16%	Loam	3	0.86	0.10	2.4	2.34	600	-	12.8	-	-	-	-	
BJ031-20CM	1			L1241433-10	4.84	2	40.1	47.8	10.9	1.15	2%	Loamy Sand	5	-	-	5.0	-	-	-	13.3	-	-	-	-	
BJ022-20CM	1			L1241433-11	4.81	2	31.7	53.1	12.3	2.86	4%	Loamy sand	5	0.4	0.05	2.8	2.78	500	1.41	14.0	0.52	0.25	0.25	-	2%
BJ022-60CM			1	L1241433-12	4.80	2	31.2	46.1	19.1	3.60	5%	Sandy loam	4	0.35	0.05	1.8	1.84	250	0.87	11.5	0.25	0.25	0.25	N/A; Na<DL	2%
BJ021-20CM	1			L1241433-13	4.62	2	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
12-7137-20CM (BJ013)	1			L1241433-14	4.96	2	17.7	56.6	19.6	6.12	7%	Sandy loam	4	0.4	0.05	3.4	3.40	250	1.01	14.9	0.25	0.25	0.25	N/A; Na<DL	2%
12-7137-60CM (BJ013)			1	L1241433-15	4.30	1	-	-	-	-		-		0.4	0.05	1.4	1.42	250	-	-	-	-	-	-	
12-7168-20CM	1			L1241433-16	5.68	4	-	-	-	-		-		-	-	4.1	-	-	-	-	-	-	-	-	
12-7167-20CM	1			L1241433-17	4.90	2	27.6	35.8	28.5	8.13	11%	Loam	3	-	-	5.0	-	250	-	25.9	-	-	-	-	
12-7167-40CM		1		L1241433-18	4.86	2	23.0	39.5	28.1	9.51	12%	Loam / Sandy loam	3	-	-	4.0	-	250	-	25.9	-	-	-	-	
BJ025-20CM	1			L1241433-19	3.82	1	29.4	32.1	28.6	9.92	14%	Loam	3	-	-	5.4	-	-	-	25.2	-	-	-	-	
BJ025-60CM			1	L1241433-20	4.30	1	49.0	30.5	16.4	4.07	8%	Sandy loam	4	0.35	0.05	3.6	-	250	-	22.3	-	-	-	-	
12-7108-20CM	1			L1241433-21	5.06	3	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
12-7162-20CM	1			L1241433-22	3.82	1	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
BJ018-20CM	1			L1241433-23	4.86	2	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
12-7168-20CM	1			L1241433-24	4.03	1	8.82	25.3	56.8	9.11	10%	Silt loam	3	-	-	21.3	-	1400	1.19	80.5	0.25	0.25	0.25	-	0%
12-7168-60CM			1	L1241433-25	4.36	1	22.1	44.4	27.6	5.85	8%	Sandy loam	4	-	-	6.8	-	250	0.25	37.7	0.25	0.25	0.25	N/A; Na<DL	1%
BJ REF EAST 1-20CM	1			L1241433-26	4.18	1	-	-	-	-		-		-	-	5.4	-	-	-	-	-	-	-	-	
BJ REF SOUTH-20CM	1			L1241433-27	5.04	3	-	-	-	-		-		-	-	2.5	-	-	-	-	-	-	-	-	
BJ CAMP 4-20CM	1			L1241433-28	4.82	2	-	-	-	-		-		-	-	2.5	-	-	-	-	-	-	-	-	
BJ CAMP 1-20CM	1			L1241433-29	4.98	2	-	-	-	-		-		-	-	0.9	-	-	-	-	-	-	-	-	
BJ CAMP 2-20CM	1			L1241433-30	4.53	2	-	-	-	-		-		-	-	2.5	-	-	-	-	-	-	-	-	
BJ015-60CM			1	L1241433-31	5.33	3	20.8	39.0	26.0	14.2	18%	Loam	3	0.35	0.05	0.8	0.82	250	-	5.9	-	-	-	-	
BJ REF NORTH 2-20CM	1			L1241433-32	5.29	3	18.4	34.7	38.8	8.08	10%	Silt loam	3	-	-	4.1	-	600	9.93	23.7	2.16	0.25	0.25	-	1%
BJ REF NORTH 2-60CM			1	L1241433-33	5.23	3	-	-	-	-		-		-	-	3.2	-	250	-	-	-	-	-	-	
V030-20CM	1			L1241433-34	5.06	3	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
V030-60CM			1	L1241433-35	5.69	4	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
BJ REF WEST-20CM	1			L1241433-36	4.82	2	-	-	-	-		-		-	-	3.7	-	-	-	-	-	-	-	-	
BJ REF EAST 2-20CM	1			L1241433-37	4.58	2	-	-	-	-		-		-	-	1.9	-	-	-	-	-	-	-	-	
BJ REF NORTH 1-20CM	1			L1241433-38	4.74	2	-	-	-	-		-		-	-	2.7	-	-	-	-	-	-	-	-	
BJ030-20CM	1			L1241433-39	6.44	5	38.1	59.5	1.94	0.47	1%	Sand	5	0.4	0.05	0.4	0.44	800	1.57	1.6	0.25	0.25	0.25	-	15%
BJ030-60CM			1	L1241433-40	6.60	6	43.4	52.2	3.45	0.91	2%	Sand	5	0.35	0.05	0.4	0.44	800	4.39	1.8	0.25	0.25	0.25	-	14%
SOIL 4-20CM	1			L1241433-41	4.34	1	-	-	-	-		-		-	-	5.5	-	-	-	-	-	-	-	-	
SOIL 1-20CM	1			L1241433-42	4.08	1	-	-	-	-		-		-	-	3.4	-	-	-	-	-	-	-	-	
SOIL 3-20CM	1			L1241433-43	3.82	1	-	-	-	-		-		-	-	3.7	-	-	-	-	-	-	-	-	
SOIL 2-20CM	1			L1241433-44	4.61	2	-	-	-	-		-		-	-	4.0	-	-	-	-	-	-	-	-	
LEACH SITE 3-20CM	1			L1241433-45	4.22	1	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
LEACH SITE 1-20CM	1			L1241433-46	4.65	2	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
LEACH SITE 2-20CM	1			L1241433-47	4.08	1	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
DUP1 (12-7137_20)	1			L1241433-48	5.07	3	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
DUP2 (12-7105_20)	1			L1241433-49	7.35	7	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
DUP3 (BJ-REF-EAST 2-20)	1			L1241433-50	4.56	2	-	-	-	-		-		-	-	-	-	-	-	-	-	-	-	-	
count	38	1	11	count	50	50	18	18	18	18	18		18	11	11	35	10	16	9	18	9	9	9		9
Total Samples	50			MAX	8.1	8	49.0	62.9	56.8	14.2	0.2		5.0	14.4	1.7	21.3	3.4	1,400	21.8	80.5	2.2	0.3	0.3		0.2
				Min	3.8	1	5.3	25.3	1.9	0.5	0.0		3.0	0.4	0.1	0.4	0.4	250	0.3	1.6	0.3	0.3	0.3		0.0
				Median	4.8	2	25.3	45.3	22.9	6.0	0.1		4.0	0.4	0.1	3.4	1.6	250	1.4	14.5	0.3	0.3	0.3		0.0
				Average	5.0	2.5	26.2	43.9	23.6	6.4	0.1		3.9	2.4	0.3	3.9	1.7	497	4.7	20.8	0.5	0.3	0.3		0.0

Notes:

Numbers shaded indicate calculated or adjusted from below detection (if below detection then calculated as one half of the detection limit)

Comparison of the paired topsoil and subsoil confirms the trend of decreasing organic matter accumulation with depth. Paired difference calculations in total carbon (by combustion) for 10 sites show a median difference of 1.3% carbon (i.e., increase in carbon in the surface compared to subsoil). This trend confirms the basis for selective surface soil topsoil handling separate from the un-weathered parent materials.

The presence of organic matter strongly influences the CEC of local soils as increasing carbon content shows a positive relationship with increasing CEC. This is discussed further in Section 7.2.3.5.

7.2.3.4 Soil Texture

Soil texture is generally assessed in the field by hand texturing. Most field textures indicate soils to be coarse to moderately coarse and medium textured.

Samples for lab testing were selected for particle size analyses to reflect of range of field textures, from fine to coarse, as found in areas associated with proposed development. Field log textures include: sandy clay loam (n = 3), loam (n = 1), sand (n = 1) and silt (n = 2).

The lab results confirm that soils in the Project area display a range of texture classes from medium to very coarse. Based on the lab data, the moderately fine rated (Sandy Clay Loam - SCL), field textures may overestimate the clay content and may actually include slightly coarser, Loam textured materials. This is indicated by the median clay content of the 18 samples tested is moderately low, 8%, though it ranges from 1% to 18%.

7.2.3.5 Cation Exchange Capacity (CEC) and Exchangeable Cations

The CEC reflects the soils ability to retain cations in an exchangeable form, an important characteristic for root zone fertility. CEC reflects the presence of colloidal materials, typically humus and clay-size mineral material, within the soil profile. Samples were selected to typify local soil conditions, both near surface and at depth. This allows comparison of topsoil versus subsoil of common soil materials, and includes a range of textures and soil reaction classes. Variation in samples included:

- surface samples (typically 20 cm depth — with elevated organic matter 'humus' content) paired with subsoil samples (typically 60 cm depth — very low organic matter content);
- field assessed soil textures ranging from coarse to medium (Sand, Loam to Sandy Clay Loam); and
- soil pH ranging from extremely acidic to mildly alkaline (pH 3.8 to 7.6).

The Lab results display a relatively wide range of CEC, from an extreme low of 1.6 meq 100 g^{-1} to a high of 80.5 meq 100 g^{-1}, for the 18 samples (17 mineral soil samples and one organic soil sample). The median CEC is moderately low, approximate 15 meq 100 g^{-1}. As anticipated the lowest CEC is associated with the coarsest textured material (sand) with the lowest organic matter content (low total/organic carbon) as seen with the two samples from site BJ030.The highest CEC is associated with an organic, surface sample from site 12-7168a very high carbon content (21.3% C), and moderately high clay content (10% clay) relative to other samples. Soils generally display relatively low CEC in the soil fraction, and, when combined with the commonly high coarse fragment content and high precipitation, likely results in a very limited nutrient holding capacity.

Exchangeable cation concentrations were only determined on a few samples representing a range of soil reaction classes. Much of the exchange complex appears to be occupied by hydrogen ions, based on the commonly observed low pHs, i.e., only 4 of 50 samples display neutral or alkaline reaction higher. The highest % base saturation is associated with soils displaying an alkaline reaction. Such conditions

are present at site 12-7105 and BJ030, which represent soils classified as Regosols or weakly developed Brunisols. These soils display base saturation in excess of 100%, an indication of free Ca is present in the soil solution often associated with free carbonates. Most local soils exhibit a very low base saturation percentage.

7.2.4 Soil Suitability Assessment for Use in Reclamation and Soil Handling Considerations

This baseline report provides sufficient information on soil attributes and soil landscapes from which more detailed soil suitability ratings and management considerations may be developed. These interpretations are typically undertaken as part of project planning during the environmental assessment process.

Individual soil inspection site and profile data will provide the majority of the physical characteristics needed for assessment. This will include the following:

- site landscape considerations: slope gradient, site drainage (as it may impact/constrain trafficability of equipment required for salvage operations); and
- soil profile descriptions provide the majority of the soil texture, coarse fragment content and soil horizon depths information used to interpret suitability ratings and develop salvage depth for SMUs.

Soil lab data will be used in determining the soil management issues related to the chemical parameters listed in the Criteria for Evaluating Suitability, as presented in Table 7.2-3.

Soil maps (SMUs) will be interpreted to show the distribution of the various suitability ratings and handling constraints in the area of the proposed project footprint(s). The soil suitability assessment and constraint map will highlight the following known project area features within the proposed development footprint area:

- areas of deep soil development and good trafficability (preferred areas of salvage);
- areas of organic soils (special handling required);
- areas of no or very limited soil development, non-soils and Regosols (i.e., areas where no special handling is required);
- areas where excess water may impact trafficability (seepage and high water tables);
- areas of excessive slope (> 50% gradient);
- areas where bedrock may impact salvage operations (outcrops and soil of shallow or irregular depth to bedrock); and
- areas where geomorphic processes (flooding, avalanches etc.) that may affect soil stockpile siting.

Additional interpretations, useful in sediment and erosion control planning, may be obtained from the soil baseline mapping and data, once project development features/footprints are known.

7.3 SENSITIVE ECOSYSTEMS

Sensitive ecosystems include those that are considered locally threatened, fragile or inherently sensitive to disturbance. Sensitive ecosystems assessed in this chapter as valued components include CDC (listed) ecosystems, riparian and floodplain ecosystems, alpine and parkland ecosystems, old forest ecosystems,

and herbaceous meadow ecosystems. Wetland ecosystems are assessed separately in the wetlands baseline report (Rescan 2013b).

7.3.1 CDC (Listed) Ecosystems

Twelve terrestrial and wetland ecosystems that are blue- or red-listed by the BC Conservation Data Centre (BC CDC) were either mapped within the LSA or RSA, or were identified during the terrestrial ecosystem or wetland field surveys within the LSA or RSA (Table 7.3-1). Several blue-listed ecosystems are difficult to model and delineate as their landscape position and moisture regimes are similar to others. For this reason, PEM has consolidated the following ecosystems into combined units (CWHwm/06 and 07, CWHwm/09 and 10, and ICHvc/05 and 04).

Table 7.3-1. Listed Ecosystems Mapped or Predicted in the Study Areas

Scientific Name	English Name	Ecosystem Unit/ Map Code	CDC Status	LSA (ha)	RSA (ha)
Terrestrial Ecosystems					
Picea sitchensis - Rubus spectabilis Wet Maritime	Sitka spruce - Salmonberry Wet Maritime	CWHwm05/ SS[1]	Blue	0	247.9
Tsuga heterophylla - Picea sitchensis - Hylocomium splendens	Western hemlock - Sitka spruce - Step moss	CWHwm02/ HM[1]	Blue	0	530.7
Populus trichocarpa - Abies lasiocarpa - Oplopanax horridus; Populus trichocarpa / Picea spp. *- Cornus stolonifera)*	Black cottonwood - Subalpine fir - Devil's club; Black cottonwood/ Spruce (hybrid) - Red-osier dogwood)	ICHvc00/ Fm03; [ICHvc05/CD[2,3]]	Blue	32.4 [981.9]	3,276.3
Populus trichocarpa - Alnus rubra - Rubus spectabilis	Black cottonwood - Red alder - Salmonberry	CWHwm06/ CD[1,2]	Blue	0	423.9
Populus trichocarpa - Abies lasiocarpa - Oplopanax horridus (Populus trichocarpa / Picea spp. *- Cornus stolonifera)*	Black cottonwood - Subalpine fir - Devil's club; Black cottonwood / Spruce (hybrid) - Red-osier dogwood	ESSFwv00/ Fm03	Blue	45.3	27.3
Alnus incana - Equisetum arvense	Mountain alder - Common horsetail	ICHvc00/ Fl01[1]	Blue	0	Not mapped
Wetland Ecosystems					
Alnus incana - Athyrium filix-femina (Alnus incana - Cornus stolonifera - Athyrium filix-femina, Alnus incana - Lysichiton americanum - Athyrium filix-femina)	Mountain alder - Red-osier dogwood - Lady fern	ICHvc00/52 (Fl02, Ws01)[1]	Blue	116.8	1398.7
Carex sitchensis - Sphagnum spp.	Sitka sedge - Peat-mosses	ICHvc00/ Wf51[1]	Red	0	1,022.5
Tsuga heterophylla - Sphagnum girgensohnii	Western hemlock - Common green peat-moss	CWHwm08/ HS[1]	Blue	0	222.3
Picea sitchensis - Lysichiton americanum (Thuja plicata - Tsuga heterophylla - Lysichiton americanum)	Sitka spruce - Skunk cabbage (Western red cedar - Western hemlock - Skunk cabbage)	CWHwm09/ SC[1,2] (Ws54)	Blue	0	177.4

(continued)

Table 7.3-1. Listed Ecosystems Mapped or Predicted in the Study Areas (completed)

Scientific Name	English Name	Ecosystem Unit/ Map Code	CDC Status	LSA (ha)	RSA (ha)
Wetland Ecosystems (*cont'd*)					
Myrica gale - Carex sitchensis	Sweet gale - Sitka sedge	CWHwm00/Wf	Red	0	29.6
Carex sitchensis - Oenanthes sarmentosa	Sitka sedge - Pacific water-parsley	CWHwm00/Wm50[1]	Blue	0	71.5

[1] *Field-identified in 2009 baseline (any BGC unit), incl. wetland plots (Rescan 2013b).*
[2] *Areas of these ecosystems may be less than stated, particularly for those predicted by PEM. Lumped units include: CWHwm06/CD and 07/CW; CWHwm09/SC and 10/LS; ICHvc05 (CD) and 04/DD.*
[3] *Although not technically listed by the BC CDC, correspondence with BC CDC personnel suggests that this is an issue of limited data on their distribution.*

Table 7.3-2 summarizes the CDC listed ecosystems mapped within the respective sub-areas. Listed ecosystems, consisting of floodplain forest ecosystems and wet, alder-dominated shrub ecosystems, comprise approximately 4% of the LSA, with all of them occurring within the lowest elevation BEC unit (ICHvc) within the Access Road Sub-area. As the ICHvc/00 WH ecosystem (generic herb-dominated wetland) *could* represent the red-listed ICHvc/00 Wf51 wetland, which has been previously identified within the RSA, it is also considered a CDC listed ecosystem.

Table 7.3-2. Listed Ecosystems Mapped within the LSA

BEC Unit(s)	Ecosystem Name	Map Code	General Ecosystem Type	Mine Site (ha)	TLSO (ha)	Access Road (ha)	Total Area (ha)	% of LSA
ICHvc/05	ActSx - Dogwood	CD	Floodplain Forest	0	0	981.9	981.9	3.1%
ICHvc/00	Black cottonwood - Subalpine fir - Devil's club	Fm03	Floodplain Forest	0	0	32.4	32.4	0.1%
ESSFwv/00	Black cottonwood - Subalpine fir - Devil's club	Fm03	Floodplain Forest	0	0	45.3	45.3	0.1%
ICHvc/00	Herb Wetland (undescribed)	WH	Wetland Shrub/Herb	0	0	29.9	29.9	0.1%
ICHvc/00	$Mountain alder – Lady fern	52	Wetland Shrub/Herb	0	0	116.8	116.8	0.4%
Total				**0**	**0**	**1,206.3**	**1206.3**	**3.8%**

7.3.2 Riparian and Floodplain Ecosystems

Table 7.3-3 summarizes the riparian and floodplain ecosystems mapped within the respective sub-areas. Riparian and floodplain ecosystems that are listed by the CDC (i.e., ICHvc/05) are included within Table 7.3-1 and excluded from this section. Mapped riparian and floodplain ecosystems comprise approximately 7 % of the LSA, with the majority mapped along valley bottoms within the Access Road Sub-area. These ecosystems include floodplain forests, wet forests, wetland forests and wet shrub thickets that are typically dominated by a variety of *Salix* shrubs.

Table 7.3-3. Riparian and Floodplain (Non-listed) Ecosystems Mapped within the LSA

BEC Unit(s)	Ecosystem Name	Map Code	General Ecosystem Type	Mine Site(ha)	TLSO (ha)	Access Road (ha)	Total Area (ha)	% of LSA
ICHvc/04	Sx - Devil's club - Dogwood	DD	Floodplain Forest	0	0	577.5	577.5	1.8%
ICHvc/06	Sx - Horsetail	SH	Wetland Forest	0	0	130.1	130.1	0.4%
ICHvc/00	Willow Thicket	WT	Wetter Shrub/Herb	0	0	29.1	29.1	0.1%
ESSFwv/06	Bl - Devil's club - Lady fern	FD	Wetter Forest	0	21.4	805.2	826.6	2.6%
ESSFwv/09	Bl - Lady fern - Horsetail	FL	Wetland Forest	0	0	316.9	316.9	1.0%
ESSFwv/00	Undescribed floodplain	FP	Floodplain Forest	0	0	242.5	242.5	0.8%
ESSFwv/07	Bl - Valerian - Sickle moss	FV	Wetter Forest	0	0	109.7	109.7	0.3%
ESSFwv/00	Willow Thicket	WT	Wetter Shrub/Herb	0	0.0	28.8	28.8	0.1%
MHmm1/06	HmYc - Deer cabbage	MD	Wetter Forest	0	15.0	0	15.0	0.0%
MHmm1/09	YcHm - Skunk cabbage	YC	Wetland Forest	0	13.0	0	13.0	0.0%
MHmm2/06	HmYc - Deer cabbage	MD	Wetter Forest	0	1.3	0	1.3	0.0%
MHmm2/09	YcHm - Skunk cabbage	YC	Wetland Forest	0	0.8	0	0.8	0.0%
Total				**0**	**51.5**	**2,239.9**	**2,291.4**	**7.2%**

7.3.3 Vegetated Alpine and Parkland Ecosystems

Tables 7.3-4 and 7.3-5 summarize the vegetated alpine and parkland ecosystems, respectively, mapped within each of the sub-areas. In total, vegetated alpine ecosystems comprise approximately 2% of the total LSA area. Vegetated parkland ecosystems, including parkland ecosystems mapped within the lower elevation MH and ESSF BEC zones, comprise approximately 9% of the total LSA area, with the majority occurring within the TLSO Sub-area.

Table 7.3-4. Vegetated Alpine Ecosystems Mapped within the LSA

BEC Unit(s)	Ecosystem Name	Map Code	General Ecosystem Type	Mine Site (ha)	TLSO (ha)	Access Road (ha)	Total Area (ha)	% of LSA
CMAun / BAFAun	Fescue Lichen	FC	Drier Herb	44.0	0.4	33.4	77.8	0.2%
CMAun / BAFAun	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	5.8	268.7	69.3	343.8	1.1%
CMAun / BAFAun	Herb Meadow	AM	Mesic Herb	117.6	7.9	136.1	261.6	0.8%
CMAun	Cryptogam - Altai Fescue	CG	Drier Herb	44.0	0		44.0	0.1%
CMAun	Herb Wetland (undescribed)	WH	Wetland Shrub/Herb	5.8	0	0	5.8	0.0%
CMAun / BAFAun	Krummholz	KH	Parkland Forest/ Krummholz	0	39.1	4.2	43.4	0.1%
Total				**217.3**	**316.1**	**243.0**	**776.5**	**2.4%**

Table 7.3-5. Vegetated Parkland Ecosystems Mapped within the LSA

BEC Unit(s)	Ecosystem Name	Map Code	General Ecosystem Type	Mine Site (ha)	TLSO (ha)	Access Road (ha)	Total Area (ha)	% of LSA
MHmmp / ESSFwvp	Krummholz	KH	Parkland Forest/ Krummholz	125.3	645.5	83.7	854.5	2.7%
MHmm1 / Hmm2 / ESSFwv	Krummholz	KH	Parkland Forest/ Krummholz	0	144.1	4.9	149.0	0.5%
MHmmp / ESSFwvp	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	12.4	619.4	66.6	698.5	2.2%
MHmm1 / Hmm2 / ESSFwv	Mountain-heather - Partridgefoot	MP	Mesic Shrub/Herb	0	49.2	1.4	50.6	0.2%
MHmmp / ESSFwvp	Parkland Forest	PK	Parkland Forest/ Krummholz	11.8	482.8	29.6	524.2	1.6%
MHmm1 / MHmm2	Parkland Forest	PK	Parkland Forest/ Krummholz	1.6	13.2	0	14.8	0.0%
MHmmp / ESSFwvp	Herb Meadow	AM	Mesic Herb	54.8	136.7	141.8	333.3	1.0%
ESSFwv	Cryptogram - Altai Fescue	CG	Drier Herb	0	0.0	0.5	0.5	0.0%
MHmmp / ESSFwvp	Deciduous Shrub	51	Wetter Shrub/Herb	2.1	36.1	44.8	83.1	0.3%
MHmmp	Alder Thicket	AT	Deciduous Shrub	0.0	5.6	0	5.6	0.0%
MHmmp	HmBa - Mountain-heather	MM	Drier Forest	0.0	1.6	0	1.6	0.0%
MHmmp / ESSFwvp	Fescue Lichen	FC	Drier Herb	22.6	0.9	2.4	25.9	0.1%
ESSFwvp	Willow Thicket	WT	Wetter Shrub/Herb	0.0	0.1	0	0.1	0.0%
Total				**230.7**	**2,135.3**	**375.7**	**2,741.7**	**8.6%**

7.3.4 Old Forest Ecosystems

Table 7.3-6 summarizes the old forest ecosystems mapped within the respective sub-areas. Old forest ecosystems comprise approximately 13% of the total LSA area, with the majority occurring within the Access Road Sub-area.

Table 7.3-6. Old Forest Ecosystems Mapped within the LSA

Mine Site (ha)	TLSO (ha)	Access Road (ha)	Total Area (ha)	% of LSA
62.5	903.4	3,272.9	4238.8	13.3%

7.3.5 Herbaceous Meadow Ecosystems

Table 7.3-7 summarizes the herbaceous meadow ecosystems, excluding those identified within the alpine and parkland BEC units, mapped within the respective sub-areas. The AM herbaceous meadow ecosystem comprises approximately 0.3% of the LSA and occurs primarily within the TLSO and Access Road Sub-areas.

Table 7.3-7. Herbaceous Meadow Ecosystems Mapped within the LSA

BEC Unit(s)	Ecosystem Name	Map Code	General Ecosystem Type	Mine Site (ha)	TLSO (ha)	Access Road (ha)	Total Area (ha)	% of LSA
MHmm1	Herb Meadow	AM	Mesic Herb	0	28.1	0	28.1	0.1%
MHmm2	Herb Meadow	AM	Mesic Herb	0.6	27.9	0	28.5	0.1%
ESSFwv	Herb Meadow	AM	Mesic Herb	0	0	36.3	36.3	0.1%
Total				**0.6**	**56.0**	**36.3**	**92.9**	**0.3%**

7.4 PLANTS OF CONSERVATION INTEREST

7.4.1 List of Potential Rare Plant and Lichen Species

In total, 235 species were included in the potential rare species list (Appendix 8), including 90 lichens, 62 mosses, and 83 vascular plants. The list at the outset of the field work included different species than those included at the end of the field surveys. Some species ranked as conservation priorities were found during the field surveys to be more common than previously thought; in other cases due to the discovery of species not previously known from British Columbia and that are rare or undescribed and potentially new to science.

7.4.2 Rare Plant and Lichen Species Found within the LSA and Surrounding Area

Seventy-six rare plant and lichen species were identified during the 2012-2013 surveys, consisting of 19 vascular plant, 42 lichen and 15 moss species (Table 7.4-1). Of these, 59 species listed by the BC CDC were identified in the LSA, including 34 macrolichens, 13 vascular plants, and 12 mosses. Of the seventeen species considered rare but previously undocumented in British Columbia, new to science or ranked as SU (i.e., uncertain by the BC CDC), six are vascular plants, eight are lichens, and three are mosses. None of the rare species found are currently listed under SARA or by COSEWIC. In total, 231 tracked species occurrences (element occurrences) were recorded. Tables 7.4-2 to 7.4-4 summarize the NatureServe and BC CDC ranks for the identified lichens, mosses and vascular plants. The location of rare plant and lichen species are illustrated in Figures 7.4-1 and 7.4-2. Surveys completed in 2012 occurred within the Mine Site and Access Road Sub-areas, and the 2013 surveys occurred along the Transmission Line – South Option.

Table 7.4-1. Summary of Rare Plant and Lichen Species found in the LSA and Surrounding Area

Conservation Rank	Vascular Plants	Lichens	Mosses
S1 (Red-listed)	0	8	0
S1S2 (Red-listed)	0	3	4
S1S3 (Red-listed)	3	0	0
S2 (Red-listed)	0	5	2
S2S3 (Blue-listed)	7	10	2
S2S4 (Blue-listed)	0	1	0
S3 (Blue-listed)	3	6	4
S3? (Blue-listed)	0	1	0
SARA	0	0	0
Non-Listed Rare Species	6	8	3
Total	**19**	**42**	**15**

Table 7.4-2. Rare Lichens Identified in the LSA and Surrounding Area

Lichen Name	NatureServe and BC CDC Ranks
Allantoparmelia almquistii	S3; Blue-listed
Arctoparmelia incurva	S2S3; Blue-listed
Baeomyces carneus	S1; Red-listed
Bryocaulon hyperboreum	Not ranked, previously undocumented in BC
Bryoria nitidula	S2S3; Blue-listed
Cetraria delisei	S3; Blue-listed
Cetraria nigricans	S3; Blue-listed
Cladonia coccifera	S1; Red listed
Cladonia macrophylla	S2; Red-listed
Cladonia pseudalcicornis	S2S3; Blue-listed
Cladonia singularis	S3; Blue-listed
Cladonia subfurcata	S2S3; Blue-listed
Collema ceraniscum	S1; Red-listed
Collema crispum	S1, Red-listed
Collema cristatum var. *marginale*	S2; Blue-listed
Collema glebulentum	S2S3; Blue-listed
Collema sp. nov.	Not ranked, a species new to science, known only from the Project area
Dermatocarpon leptophyllodes	S2S4; Blue-listed
Fuscopannaria cheiroloba	A rare species known from very few populations in its rather limited range
Hydrothyria venosa s. lat.	S1S2; Red-listed
Lempholemma intricatum	S1S2; Red-listed
Leptogium cyanescens	S1; Red-listed
Leptogium imbriactum	Not ranked, previously undocumented in BC (previous reports from BC have proven incorrect)
Nodobryoria subdivergens	S2S3; Blue-listed
Parmelia skultii	S1; Red-listed
Phaeophyscia cf. *nigricans*	*Phaeophyscia nigricans* is ranked S1; Red-listed- see rare plant report for additional rank information on this species
Placynthium asperellum	S3?; Blue-listed
Solorina bispora	S2S3; Blue-listed
Solorina octospora	S3; Blue-listed
Solorina spongiosa	S2; Red-listed
Sphaerophorus fragilis	S2S3, Blue-listed
Steineropsis alaskana	Not ranked, newly discovered for BC, globally rare
Stereocaulon arenarium	S2; Red-listed
Stereocaulon botryosum	S2; Red-listed
Stereocaulon capitellatum	S1; Red-listed
Stereocaulon depressum	S1; Red-listed
Stereoculon glareosum	S2S3; Blue-listed
Stereocaulon symphycheilum	S1S2; Red-listed
Umbilicaria lambii	S3; Blue-listed
Umbilicaria sp. nov.	Not ranked; a new species known only from the Project area
Vahliella leucophaea	Not ranked; previously undocumented in BC
Vestergrenopsis elaeina	S2S3; Blue-listed

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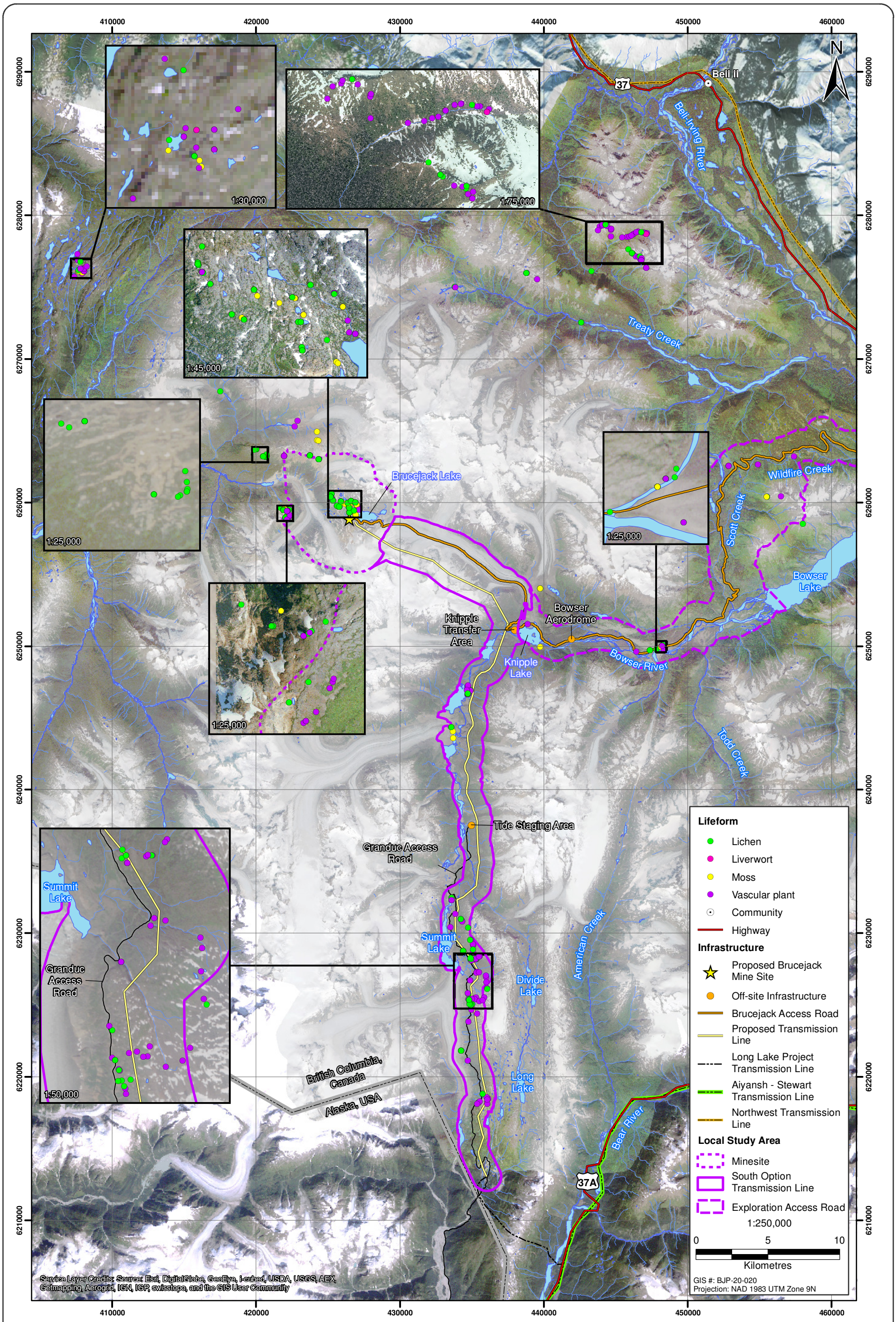

Figure 7.4-1

PRETIVM

Rare Plant and Lichen Observations in the Brucejack Local and Regional Study Areas

Figure 7.4-1

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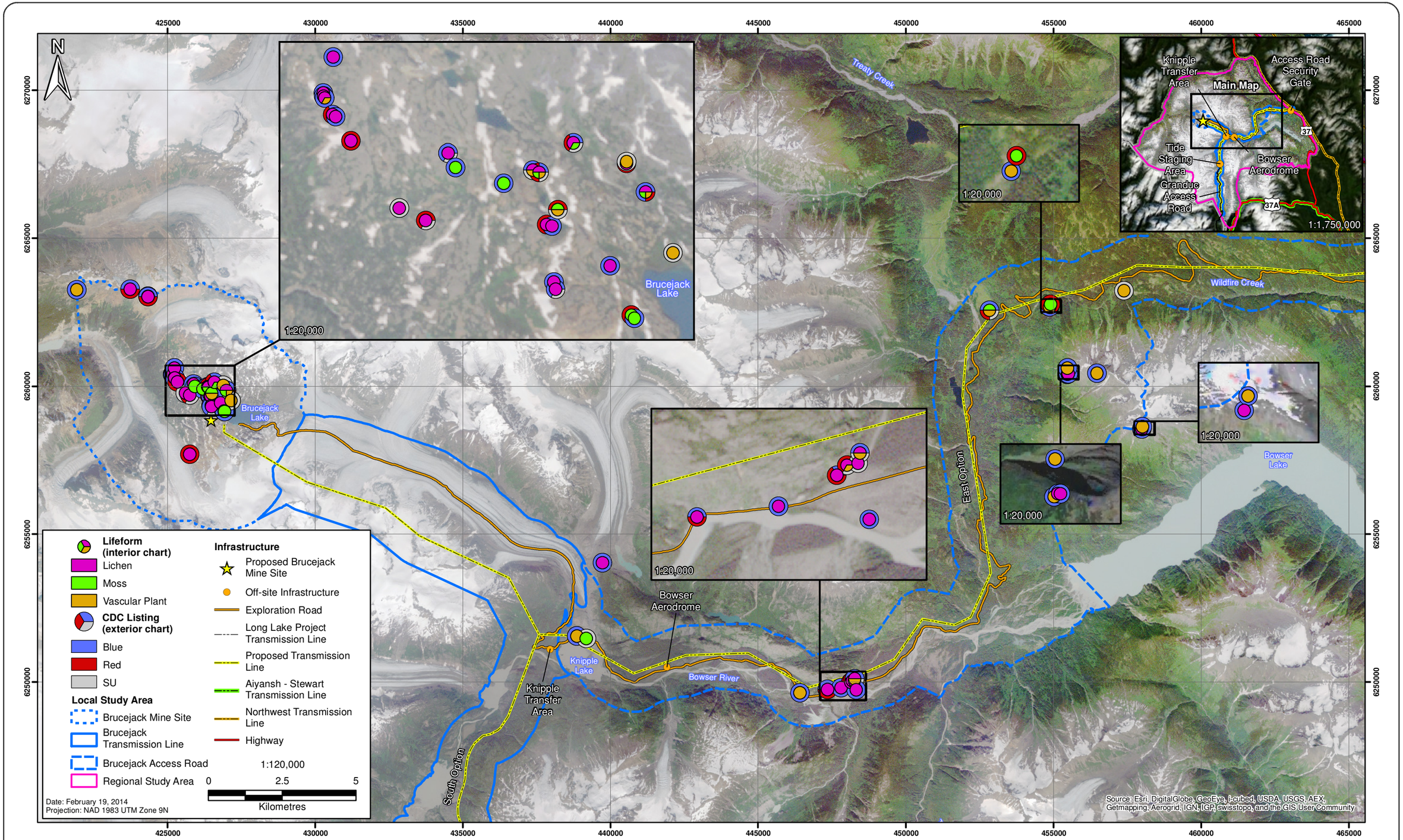

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Figure 7.4-2

Rare Plant and Lichen Observations within the Mine Site and Access Road Sub-areas

Table 7.4-3. Rare Mosses Identified in the LSA and Surrounding Area

Moss Species	NatureServe and BC CDC Ranks
Amblyodon dealbatus	S3; Blue-listed
Andreaea sinuosa	S2; Red-listed
Bryum calobryoides	S1S2; Red-listed
Dicranum montanum	S3; Blue-listed
Helodium paludosum	Not ranked, but otherwise known in BC from only two localities
Mielichhoferia elongata	Not ranked, but the present population is apparently the only one documented thus far from British Columbia; said in literature to be globally rare, though this is not reflected by the perhaps erroneous NatureServe rank of G4 (NatureServe 2012)
Plagiobryum demissum	S1S2; Red-listed
Pohlia cardotii	S2; Red-listed
Pohlia sp. nov.	Not ranked, a rare new species
Psilopilum cavifolium	S1S2; Red-listed
Ptychostomum schleicheri	S2S3; Blue-listed
Sarmentypnum pseudosarmentosum	S3; Blue-listed
Sphagnum annulatum	S1S2; Red-listed
Sphagnum aongstroemii	S2S3; Blue-listed
Tomentypnum falcifolium	S3; Blue-listed

Table 7.4-4. Rare Vascular Plants Identified in the LSA and Surrounding Area

Vascular Plant Species	NatureServe and BC CDC Ranks
Antennaria howellii × *alpina*	Not ranked, an anomalous taxon not previously known to science
Botrychium crenulatum	S2S3; Blue-listed
Carex enanderi	S2S3; Blue-listed
Carex praeceptorum	S1S3; Red-listed
Carex rostrata × *utriculata*	S2S3; Blue listed (rank of *C. rostrata*)
Carex sp. nov.	Not ranked, previously misreported as *Carex atrata*
Draba glabella	S2S3; Blue-listed
Draba sp. nov.	Not ranked; a rare new species known only from the northern BC Coast Ranges
Epilobium davuricum	S1S3; Red-listed
Epilobium hornemannii ssp. *behringianum*	S2S3; Blue-listed
Epilobium leptocarpum	S2S3; Blue-listed
Epilobium x treleasianum	S3; Blue-listed
Gymnocarpium jessoense ssp. *parvulum*	S3; Blue-listed
Micranthes nelsoniana var. *carlottae*	S3; Blue-listed
Micranthes nelsoniana var. nov.	Not ranked; a rare plant new to science
Polypodium cf. *interjectum*	Not ranked, a possible taxonomic novelty, rare
Ranunculus occidentalis var. *hexasepalus*	S1S3; Red-listed
Woodsia alpina	S2S3; Blue-listed

Currently, none of the documented rare species are listed under SARA; however, several species are considered rare world-wide due to how seldom they have been documented. Among these are species given G-ranks of G2G3 through G3G4 threatened, sensitive or possibly sensitive. This is true of *Bryum calobryoides* (G3), *Nodobryoria subdivergens* (G2G3), *Pohlia cardotii* (G2G3), *Sphagnum aongstroemii* (G3G4), *Stereocaulon symphycheilum* (G3), and *Umbilicaria lambii* (G2G4). Furthermore, the NatureServe system has completed G ranks for only a portion of the total North American flora, so many of the globally rare species on the continent are not yet flagged as conservation priorities. For example, *Bryocaulon hyperboreum, Cladonia pseudalcicornis, Cladonia singularis, Cladonia subfurcata, Fuscopannaria cheiroloba, Lempholemma intricata, Ranunculus occidentalis* var. *hexasepalus* are not assigned global conservation ranks, but are so seldom reported that they are likely of global-scale conservation priority. Species new to science that are known only from the Project or from few populations elsewhere in the BC Coast Ranges may also merit global-scale conservation ranking, including *Carex* sp. nov., *Collema* sp. nov., *Draba* sp. nov., *Micranthes nelsoniana* var. nov., and *Umbilicaria* sp. nov.

Some species encountered in the 2012 and 2013 surveys that were previously thought rare are now known to be too common to merit conservation ranking at the present time, including *Castilleja unalaschcensis, Drepanocladus aduncus, Lempholemma polyanthes, Leptogium plicatile* sensu lato, *Phaeophyscia decolor, Physcia dubia,* and *Saxifraga oppositifolia* ssp. *smalliana*. These species are not given further consideration here as conservation priorities. Additionally, some species found are only tentatively identified as rare taxa. Though these species were highlighted in preliminary reporting from the 2012 rare plant surveys, additional research on these specimens revealed that their identities are currently too much in doubt to be highlighted as rare and listed taxa. These include *Cinclidium subrotundum, Dicranum flagellare, Dicranum montanum, Gemmabryum subapiculatum, Imbribryum gemmiparum, Leciophysma furfurascens, Niphotrichum pygmaeum, Schistidium atrichum, Stereocaulon arcticum,* and *Umbilicaria aprina*.

7.4.3 Rarity in Landscapes and Habitats

Most rare plants were found in open, non-forested areas, or where forest canopy cover is light. Most rare species are rare because they require rare habitats. Some rare species were found in the shade of trees, but the habitat characteristics significant to these species are associated with special habitat features such as cliffs, rock outcrops or ecotonal areas between forested and unforested habitat. Among non-forested habitats, some were found to have overall high species richness and numerous rare plants and lichens. Rare plant habitat types are listed in Table 7.4-5.

Table 7.4-5. Rare Plant Habitat Types within the LSA

Alpine	Non-alpine
Cliffs	Cliffs
Ephemeral pools	Fens
Moist Meadow	Gossen Outcrops
Rock Pinnacles	Lakeshores
Scree	Marshes
Stable Rocky Tundra	River Back-Channels and Gravel Bars

7.5 INVASIVE PLANT SPECIES

Two invasive plants, common tansy (*Tanacetum vulgare*) and oxeye daisy (*Leucanthemum vulgare*) were identified along the east side of Highway 37. This population covered approximately two to three

hectares and extended from 200 m to 800 m south of the exploration road entrance. Common tansy was also identified within a small area on the west side of Highway 37, approximately 2.8 km north of the exploration access road entrance (M. Holtby, pers. comm.). These species are classified as noxious under the Weed Control Act and extremely invasive to very invasive by the Northwest Invasive Plant Council.

7.6 LABORATORY ANALYSIS OF METALS IN SOILS, LICHENS AND PLANT TISSUE

7.6.1 Soils Analysis

A total of 50 samples (including three duplicates), from 34 soil inspection sites were obtained from across the three sub-areas (See Appendix 9, Table 3.1-1). These samples were analyzed for a suite of 31 metals, of which 19 have CCME Industrial Use Guideline criteria values (see Appendix 9, Table 3.1-2). Exceedances of the industrial criteria are deemed to be metals of concern in the following discussion of these 19 metals. Seven of the nineteen metals were noted to exceed industrial use criteria at least once. These include Sb (n = 2), As (n = 31), Cr (n = 1), Cu (n = 2), Ni (n = 8), Tl (n = 4) and V (n = 2). Soil metals no exceeding industrial use criteria include: Ba, Be, Cd, Co, Pb, Hg, Mo, Se, Ag, Sn, U, and Zn.

Arsenic is the most frequently occurring metal of concern, as in 31 of 50 samples, taken from 19 of the 34 inspection sites, it exceed the industrial guideline concentration of 12 mg kg^{-1}. This includes 11 of the 12 sampled sites in the Mine site, and four of six of the reference sites. The site with the highest concentration of As was BJ camp 2, at 883 mg/kg. At 3mg/KG Thallium and Sb exceedance were paired with As exceedance at two sites in the Mine Site, and did not occur at any other sites.

Nickel had the second highest number of soil samples exceeding the CCME guidelines. Soil nickel levels exceed CCME criteria in eight samples from six sites in the LSA (all along the exploration access road). Nickel exceedance occurred with other metals (As or Cr) at two sites. All the samples high in Ni were from the exploration access road with the ninetieth percentile (67.44 mg/kg) above the CCME guideline (50 mg/kg; Appendix 9, Table 3.1-3). Nickel concentration exceedance was not noted in the any of the other locations where samples were collected.

Copper exceedance was noted at only one site, in both surface and subsurface samples from Site 12-7168 located along the exploration access road. The concentration decreased with depth. Chromium exceeded the limit in only one sample from the exploration access road.

Thallium and As exceedances occurred in four samples from the Mine Site Sub-area. At Site 12-1705, both the surface and subsurface samples were found to be in exceedance. Vanadium exceedance was noted at two sites, but as a single metal exceedance at only one site, BJ-Ref West – 20 cm.

7.6.2 Lichen Analysis

A total of 22 lichen samples (including 3 duplicates) were collected for analysis from within the LSA and at reference sites. Lichen samples collected were confined to black footed reindeer lichen (*Cladina stygia*) and eyed foam lichen (*Stereocaulon tomentosum*). These samples were analyzed for a suite of 39 metals, which are presented in Table 3.2-1 of Appendix 9.

Metal concentration varied greatly in both *C. stygia* and *S. tomentosum*. Notably, three of these samples, all within the Mine Site Sub-area, contained higher concentrations of As than the rest of the samples. These sites also correspond to sites with elevated As in the soils. Sample BJ CAMP2 had the highest As concentration in the lichen tissue, at 7.88 mg/kg. This sample site also corresponds to the highest concentration of As in the soil sample (883 mg/kg).

Lichens sampled at the Mine Site also contained the highest concentrations of Ba and Mn but had similar concentrations of other metals when compared to all other sites. Lichen collected from sites along the proposed Transmission Line - South Option had the highest concentrations of Al, Cu, Ni, P, and K. The 2012 lichen lab results are included in Appendix 3 of Appendix 9.

7.6.3 Berry Analysis

Five species were targeted for sampling including oval leaf blueberry (*Vaccinium ovalifolium*), black huckleberry (*Vaccinium membranaceum*), bog blueberry (*Vaccinium uliginosum*), highbush cranberry (*Viburnum edule)* and soapberry (*Shepherdia canadensis*). A total of 31 berry samples were collected. Twenty one samples were collected from the Access Road Sub-area, five from the Transmission Line – South Option Sub-area, two from the Mine Site Sub-area and three from the Reference locations (see Appendix 9, Table 3.3-1).

Fourteen metals were found to be above the detection limit. Of these, nine (Al, Ba, Ca, Fe, Mg, Mo, Ni, P, and K) had the highest 90th percentile value along the Transmission Line - South Option. As noted above, As was in exceedance in soils at several locations. However, these levels did not appear to be reflected in berry samples.

7.6.4 Sedge Analysis

Thirty water sedge tissue samples were collected from ten sites within the Access Road Sub-area. The sedge samples were analyzed for 25 different metals, many of which were found to be below detection limits. In more than 50% of the samples barium, calcium, cobalt, copper, magnesium, manganese, molybdenum, nickel, strontium, zinc were found to be above detection limits. Antimony, beryllium, bismuth, chromium, lead, lithium, selenium, tin, uranium, vanadium were not detected in any sedge tissue samples, while arsenic, cadmium, mercury, thallium were detected in less than 50% of the samples. Metals with the highest overall concentrations were calcium, magnesium and manganese. The 2012 sedge lab results are included in Appendix 5 of Appendix 9.

8. Summary

8. Summary

In order to support a potential environmental assessment of the Brucejack Gold Mine Project baseline studies were initiated and carried out in 2012 and 2013. Field surveys for terrain, soils, ecosystems and vegetation were carried out in an LSA that included the exploration access road, the proposed Brucejack Transmission Line – South and East Options, and the Mine Site.

The proposed Mine Site is situated above the treeline, and contains alpine ecosystems as well as an abundance of unvegetated and sparsely terrain. Much of the area around the proposed Mine Site is disturbed. In undisturbed areas, soils derived from weathered bedrock and skeletal glacial till support alpine ecosystems, mostly Alpine Tundra Class and Alpine Heath Class. Ecosystems on colluvial slopes and other dry sites are limited to Alpine Fellfield Class and Alpine Nivation Class ecosystems. Some Subalpine Shrub group ecosystems are also present.

The exploration access road travels through old valley bottom forests, subalpine stands of subalpine fir and Engelmann spruce, and along dry glaciofluvial terraces supporting early seral pioneer ecosystems. Much of it runs through forests greater than 400 years old, containing mature and decadent hybrid white spruce and subalpine fir, with an abundance of woody berry producing shrubs. The terrain is mostly till blankets and veneers over bedrock, although some colluvium and wetlands soils area also encountered. Rare plants encountered included several red listed lichens and mosses, as well as blue listed lichens, mosses and vascular plants. The Transmission Line - East Option follows the general alignment of the exploration access road.

The Transmission Line – South Option is situated in both mature forest and recently deglaciated terrain, dominated by scoured rock, eroding moraine and glaciofluvial deposits. South of Granduc, forested zonal ecosystems of the MHmm1 and unclassified ecosystems of the MHmmp are common; at the farthest extension of the Transmission Line – South Option Sub-area, portions of the CWHwm subzone are present. In the lower elevations of the valley, along the Salmon River, the terrain is predominately composed of floodplain built up with coarse gravels and sands. Soils show little pedogenesis, typical of areas recently deglaciated. These glacial sediments are modified by post glacial processes, such as mass wasting and surface erosion. Colluvium is common, with related landforms being talus slopes, colluvial fans and boulder fields.

Five sensitive ecosystems types were observed within the LSA and/or RSA, including 12 CDC (listed) ecosystems, 12 riparian and floodplain ecosystems, 6 alpine and 10 parkland ecosystems as well as 4,239 ha of old forest ecosystems, and 93 ha of herbaceous meadow ecosystems within the LSA.

Seventy-six rare plant and lichen species were identified within the LSA, consisting of 19 vascular plant, 42 lichen and 15 moss species. Of these, 14 occur within the Mine Site sub-area, five within the exploration access road sub-area and four within the Transmission Line – South Option sub-area.

None of the rare species found are currently listed under SARA or by COSEWIC. Fifty nine of the species are listed by the BC CDC and 17 are considered rare but previously undocumented in British Columbia, new to science or ranked as SU (i.e. uncertain by the BC CDC).

Two invasive plants, common tansy (*Tanacetum vulgare*) and oxeye daisy (*Leucanthemum vulgare*) were identified along the east side of Highway 37. These species are classified as noxious under the Weed Control Act and extremely invasive to very invasive by the Northwest Invasive Plant Council.

Soils were classified and mapped into twenty-two soil groups. Soils in the LSA were classified and mapped into groups, according to similar characteristics. These groups determined by analysis available data relevant to soils within the LSA. Data used to classify soils includes terrain mapping and field data; soils field data, TEM mapping and field data, geological mapping data, drilling logs, slope and aspect. Twenty-two soil groups were identified. These groups will be used to guide soil salvage, handling and reclamation.

Samples for metals analysis were collected in order to determine baseline metals for soils, vegetation tissue, berries and lichens. A total of 50 samples (including three duplicates), from 34 soil inspection sites were obtained from across the study areas. Seven of the nineteen metals analysed for exceeded industrial use criteria at least once. These included the following: Sb, As, Cr, Cu, Ni, Tl and V. Soil metals not exceeding industrial use criteria include: Ba, Be, Cd, Co, Pb, Hg, Mo, Se, Ag, Sn, U, and Zn. Arsenic is the most frequently occurring metal of concern (31 of 50 samples tested exceed the industrial guideline concentration of 12 mg/kg.

A total of 22 lichen samples (including three duplicates) were collected from within the LSA or at reference sites. The two species of lichen samples collected were black footed reindeer lichen (*Cladina stygia*) and eyed foam lichen (*Stereocaulon tomentosum*). These samples were analyzed for a suite of 39 metals. Notably, three of these samples, all within the Mine Site, contained higher concentration of arsenic than rest of the samples. These sites also correspond to sites with elevated arsenic in the soils.

A total of 31 berry samples were collected. Five species were targeted for sampling including oval-leaved blueberry (*Vaccinium ovalifolium*), black huckleberry (*Vaccinium membranaceum*), bog blueberry (*Vaccinium uliginosum*), highbush cranberry (*Viburnum edule)* and soapberry (*Shepherdia canadensis*). Thirty water sedge (*Carex aquatilis*) samples from the ten sites within the Access Road Sub-area were also collected.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Appendix 1
PEM Methodology

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Appendix 1. PEM Methodology

Predictive Ecosystem Mappingis smapping method in BC that uses the BEC system. PEM is an automated, computer-based method using available spatial data and ecological knowledge.

The Brucejack PEM was used to characterize the distribution of ecosystem units in the Brucejack RSA. It is raster-based, with a cell size of 20 m (which relates to 20 m by 20 m on the ground). The PEM is also one of the input layers used in wildlife habitat suitability modelling (Rescan 2010e), the results of which will be used in the Wildlife and Wildlife Habitat Effects Assessment.

The Brucejack PEM was developed using the programs and procedures developed by LandMapper Environmental Solutions Inc. (LMES). The procedures are termed the LMES Direct-to-Site-Series (DSS) method and are based on two primary assumptions. The first assumption is that topography is one of the primary controlling factors behind the local flow and accumulation of water, energy, and matter in landscapes (MacMillan 2003). The flow and accumulation of water shapes the development and properties of soils and site-level environmental conditions. The second assumption is that, where subtle differences among classes are important, human-imposed classification systems are superior to those based on statistical analyses and ordination (MacMillan 2003). These assumptions, and consequently the LMES DSS procedures, parallel the logic and decision making processes outlined in the regional Field Guide produced by the BC Ministry of Forests (MoF) (Banner et al. 1993).

With the LMES DSS method, map units are identified and described using both hard (Boolean) and soft (fuzzy) logic. Boolean logic is characterized by such statements as “yes/no”, “0/1”, and “true/false.” Fuzzy logic, on the other hand, uses a concept of *degree of membership* to a particular class (MacMillan et al. 2000). With Boolean logic, a particular pixel may be classified as “wet” or “dry,” for example, whereas using fuzzy logic, that same pixel may be recognized as being 40% wet, and 60% dry, allowing for the use of such statements as “slightly dry,” and thus approximating a more “human” way of thinking (Hellmann 2001). Further detail on the LMES DSS method and its associated logic systems can be found in MacMillan (2005).

PEM INPUT COMPONENTS

Regional Climate

The location and extent of different biogeoclimatic zones, sub-zones, and variants was input to provide broad-scale information that describes the regional climate of a geographic area. BEC lines were acquired from the BC MoFR at the scale of 1:250 000. These classification zones were the initial stratification in the model; subsequent refinement into BEC unit-specific site series followed.

Land Cover

A map of land cover was created through digital image classification of satellite imagery. Image classification refers to the automated statistical process of clustering pixels based on the spectral signatures of the ground feature(s) represented in those pixels. The analyst can either define the classes a priori (termed, “supervised” classification), or can group spectral clusters into meaningful classes a posteriori (“unsupervised” classification).

Digital satellite imagery was provided by PhotoSat. SPOT5 panchromatic imagery was acquired on July 22, 2004 and September 28, 2004. This imagery is grey-scale and has a spatial resolution (i.e., pixel size) of

5 m. The panchromatic imagery was fused with true-colour imagery (colour bands red, green and blue) from the Landsat 7 ETM+ satellite (30 m spatial resolution) acquired on August 6, 2002. The fused imagery has the colour resolution of the Landsat imagery and the spatial resolution of the SPOT imagery. However, portions of the Landsat imagery were hazy; these areas were maintained as grayscale.

An unsupervised image classification was run on this fused imagery using the ISODATA algorithm and software from PCI Geomatics. Limited spectral separability among certain classes, resulting partly from the input of both gray-scale and colour data into the algorithm, required some manual editing of the classification output. Following this editing, seven land cover classes were defined: water, snow/ice, forest, barren, shrub/herb, dwarf shrub/herb, and herbaceous. The land cover map was re-sampled from a spatial resolution of 5 m to one of 20 m to match the resolution of the topographic input layers. These land cover categories were compiled into a variable called "classify" (Plate A-1) which was used in the PEM rule sets.

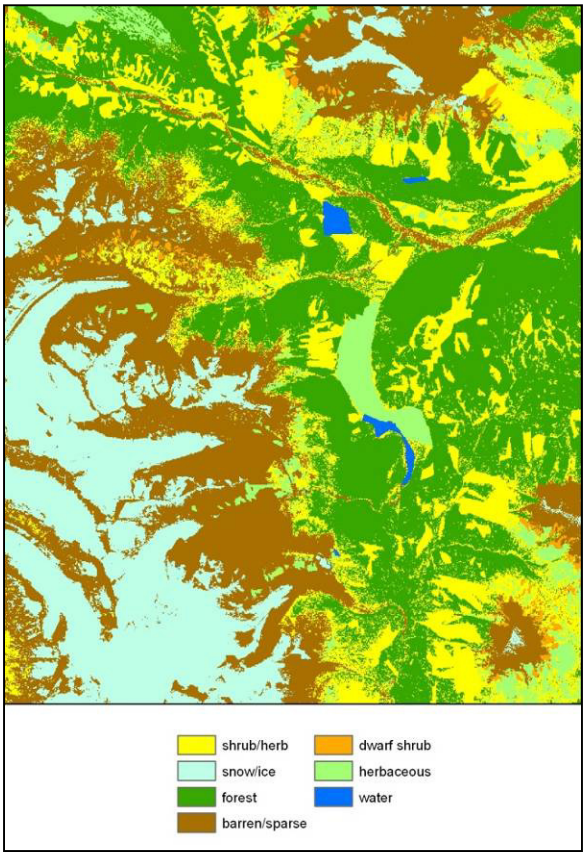

Plate A-1. Example of the Land Cover map ("classify" variable) used as input for the PEM.

Topography and Landscape Position

Terrestrial Resource Information Management (TRIM) data, including a Digital Elevation Model (DEM) (20 m pixels), was purchased from the BC government. In addition to absolute relief (elevation), a number of other derivatives from the DEM were used as input variables. These variables include descriptors of local shape and orientation (i.e., aspect, slope gradient and curvature), and of relative slope position (e.g., "crest", "mid-slope", "toe-slope"). Descriptors of relative slope position include the LMES program variables "Z to pit," "Percent Z to pit," "Z to stream" (Plate A-2) and "Percent Z to stream," all of which indicate a given pixels' height above the nearest depression/stream. Another

variable of relative slope position is "LnQArea" (log of upslope, or catchment area) which indicates where on a slope a given pixel is based on how much area lies above it that would be capable of shedding water (the smaller the upslope area, the closer that pixel is to a crest). Measures of relative slope position help establish the context of each grid cell in the larger landscape. A more detailed discussion of these terrain derivatives is provided in MacMillan (2000) and MacMillan et al. (2007).

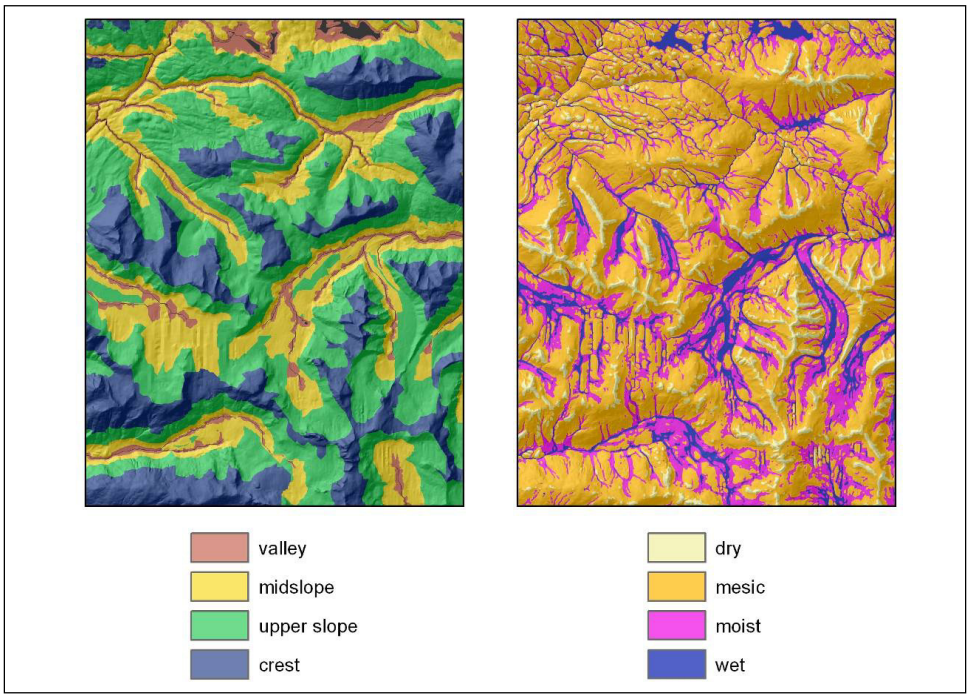

Plate A-2. Example of the Z to Stream (left) and the Qweti (right) PEM input variables.

Potential Moisture

Potential moisture is another derivative of the DEM. Potential moisture is measured using the dimensionless Quinn Wetness Index (*Qweti*). This variable approximates the concepts associated with the terms used to describe relative moisture in the regional field guides (e.g., dry, moist, wet) (Plate A-2). The general assumption associated with this variable is that water flows downhill and accumulates in level or depressed, down-slope landform positions. While reality may reflect more complex scenarios, this attribute is a reasonable predictor of relative moisture status. This variable however is not as effective in identifying seepage conditions or wet areas resulting from high water tables (e.g., sub-surface moisture).

Exceptions

Water features (lakes, rivers, wetlands) within the TRIM data were overlaid on the PEM as a final step, overriding any other map unit possibility within those locations. As well, floodplain units (largely deciduous) in structural stage 4, 5, 6 or 7 were manually delineated (in addition to being modelled). As several floodplain forests are blue-listed by the BC Conservation Data Centre (BC CDC), it was important to ensure the presence of floodplain forests were accurately mapped. Shrubby floodplain areas were mapped by the PEM as generic mesic or wet shrub/herb units.

PEM INPUT DATA QUALITY

Terrain Resource Information Management (TRIM)

The TRIM data does not capture very fine topographic variations, including small wetlands and gullies, thus the PEM may fail to accurately describe these small features. Another limitation is that the TRIM was created prior to the date of imagery capture, and the extent of some lakes, rivers and wetlands in the TRIM were noted to vary slightly from those that could be seen on the imagery. However, interpretation of the more recent satellite imagery was used to manually correct many of these discrepancies in the TRIM.

BEC Lines

The scale of provincial BEC mapping (generally 1:250,000) is "conceptual" in that it is based on knowledge of regional climate, specifically temperature and precipitation. The placement of these lines is largely related to elevational influence and continentality.

Satellite Imagery

The satellite imagery was orthorectified and projected to the same projection as the other digital data. The spatial resolution of this imagery (5 m) means that features smaller than 5 m cannot be detected. This resolution is perfectly adequate for ecosystem mapping (i.e., where the landscape is generalized into representative units).

In some areas, cloud/haze, or heavy shadow decreased the quality of the imagery, and made automatic image classification difficult. Manually editing the image was particularly helpful in these areas.

PEM ASSEMBLY

Assembly of the PEM involved combining and analyzing the various input data layers via two types of rules. Fuzzy attribute rules ("arules") were constructed to define and delineate the numerical input data into particular, semantic constructs such as "ridge," "steeply sloping," or "very wet" (MacMillan, Moon, and Coupe 2007). The mapper constructs these "arules" using likelihood models, the parameters of which are chosen based on a combination of visual review of the digital layers, and consultation of the regional field guide (Banner et al. 1993) which contains descriptions, landscape profile diagrams, and edatopic grids summarizing the site series existing in the region.

Once the attributes have been defined, the prediction of site series can begin. Fuzzy class rules ("crules") represent a distinct combination of both Boolean and fuzzy attributes that together define a particular "environmental setting" within which a particular site series/ecosystem unit (or combination of site series/ecosystem units) can be expected to occur. Environmental settings were defined on the basis of BEC units (delineated using Boolean logic), and on the basis of finer-scale environmental conditions such as relative slope position, slope gradient and elevation (i.e., the previously defined fuzzy attributes). Appendix 2 contains all the rule sets created for this PEM. It is important to note that application of these rules is not appropriate for another geographic area since they were developed using site specific ecological knowledge and site specific environmental attributes.

Rulesets that were developed for the adjacent KSM Project were used, as Brucejack and KSM used similar study areas.

PEM ASSESSMENT AND REFINEMENT

The PEM was routinely assessed and refined throughout its development using a variety of data, which included field survey data, high resolution ortho-photographs and TEM.

Field Data

Data from field plots surveyed during terrestrial ecosystemsfield studies, and herb meadow sites surveyed during marmot surveys carried out by wildlife biologists, were used to refine the land cover map derived from satellite image classification. The land cover type) identified at a particular location in the field was compared to the classified value at that same location. Where the two were not the same, the image classification was manually edited to match the field assessment. Likewise, the actual site series predicted by the PEM were compared to those mapped in the field. The PEM was refined if it did not reasonably approximate the field results.

High-Resolution Orthophotos

Orthophotos (geometrically corrected aerial photographs) at a scale of 1:20,000 were available for the TEM study area, but not for the entire PEM study area. Where available, the higher resolution orthophotos were used to manually edit and refine the image classification derived from the coarser satellite imagery. This use of orthophotos was particularly helpful in areas where shadow or cloud on the satellite imagery resulted in errors in the image classification. The orthophotos were also used in delineation of floodplain units through exceptions mapping.

Appendix 2
Field Forms

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ECOSYSTEM FIELD FORM

BRITISH COLUMBIA

MINISTRY OF FORESTS
BC ENVIRONMENT

DATE (Y M D)	PLOT NO.
PROJECT ID.	FIELD NO. / SURVEYOR(S)

SITE DESCRIPTION

LOCATION

GENERAL LOCATION

FOREST REGION	MAPSHEET	UTM ZONE	LAT./ NORTH.	LONG./ EAST.
AIRPHOTO NO.	X CO-ORD.	Y CO-ORD.	MAP UNIT	

SITE INFORMATION

PLOT REPRESENTING

BGC UNIT	SITE SERIES	TRANS./ DISTRIB.	ECOSECTION

MOISTURE REGIME	NUTRIENT REGIME	SUCCESS. STATUS	STRUCT. STAGE	REALM/ CLASS

ELEV. m.	SLOPE %	ASPECT °	MESO SLOPE POS.	SURFACE TOPOG.

NOTES

SITE DIAGRAM

SITE DISTURB.	PHOTO ROLL
EXPOS. TYPE	FRAME NOS.

SUBSTRATE (%)

ORG. MATTER		ROCKS	
DEC. WOOD		MINERAL SOIL	
BEDROCK		WATER	

FS882 (1) HRE 98/5

SOIL DESCRIPTION

GEOLOGY	BEDROCK	C. F. LITH.	SURVEYOR(S)	PLOT NO.

TERRAIN	TEXTURE 1 / 2	SURFICIAL MATERIAL 1 / 2	SURFACE EXPR. 1 / 2	GEOMORPH. PROCESS 1 / 2	PROFILE DIAGRAM

SOIL CLASS.	HUMUS FORM	HYDROGEO.

ROOTING DEPTH cm	ROOT RESTRICT. LAYER	TYPE	DEPTH cm	WATER SOURCE	SEEPAGE cm	DRAINAGE	FLOOD RG.
R. Z. PART. SIZE							

ORGANIC HORIZONS/LAYERS

HOR/ LAYER	DEPTH	FABRIC STRUCTURE	FABRIC vPOST	MYCEL. AB.	FECAL AB.	ROOTS AB.	ROOTS SIZE	pH	COMMENTS (consistency, character, fauna, etc):

MINERAL HORIZONS/LAYERS

HOR/ LAYER	DEPTH	COLOUR	ASP.	TEXT.	% COARSE FRAGMENTS G	C	S	TOTAL	SHAPE	ROOTS AB.	ROOTS SIZE	STRUCTURE CLASS	STRUCTURE KIND	pH	COMMENTS (mottles, clay films, effervesc., etc):

NOTES:

FS882 (2) HRE 98/5

VEGETATION

SPP. LIST COMP. ☐ PART. ☐ | % COVER BY LAYER TREE (A) ☐ SHRUB (B) ☐ HERB (C) ☐ MOSS / LICHEN (D) ☐ | SURVEYOR(S) | PLOT NO. | PAGE OF

TREES	A1	A2	A3	A	B1	B2	B

SHRUBS	B1	B2	B

HERB LAYER (C)	%

MOSS / LICHEN / SEEDLING (D)	%

ADDITIONAL SPECIES	LAYER	%

NOTES: _____

FS882 (3) HRE 98/5

MENSURATION

MENSURATION FORM

SURVEYOR(S):

TREE#	SPP.	DBH	HEIGHT CALCULATIONS						HT. TO DBH	TOTAL HT.	BH AGE	SI	SUP.	CONK	BL. CONK	SCAR.	F. OR C.	F. CRACK	MISTLE.	R. BRAN.	D. OR B. TOP	DAMAGE		SITE SERIES
			TOP	BOT.	SD	SL.	HD	HT.														TYPE	SEV.	

NOTES

TREE DIAMETER TALLY

TREE #	SPP.	DBH	TREE #	SPP.	DBH

FS 882 (4) HRE 98/5

BRITISH COLUMBIA

WILDLIFE HABITAT ASSESSMENT

Proj. id.		Date (y m d)		N-hab. feature	type		page	of
Plot no.		Surveyor			dst.			

Species	Hab use / Ssn	Plot type					Plot-in-context														
5-letter code	Sp. L.R.	Ssn.	FD	SH	TH	Com.	Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	FD	SH	TH	Suit.	Com.

Comments / Notes	

FS 882 (5) HRE 98/5

BRITISH COLUMBIA

WILDLIFE HABITAT ASSESSMENT

Project id.		Plot no.	

Evidence of Use

Species	Inside plot: Sex	Life Stage	Activity	Des.	No.	Com.	Outside plot and inside ecosystem unit: Sex	Life Stage	Activity	Des.	No.	Sex	Life Stage	Activity	Des.	No.	Com.

Comments / Notes	

Abbreviated Tree Attributes for Wildlife

B.A.F.		Area		Min DBH	
No. of trees		No. dead		No. live	
Avg. DBH (cm)		Avg. length (m)			
Avg. lich load class		Comments			

Simple Coarse Woody Debris Sampled ____ m of 30 m transect

	Piece #	1	2	3	4	5	6	7	8	9	10	11
Decay class												
Diam. class												
	Piece #	1	2	3	4	5	6	7	8	9	10	11
Decay class												
Diam. class												
Comments												

Management

Species (Sp. group)	Use	Ssn.	F/C LR(s)	Cap.	Mgmt. Tech.	M. Feat / Int	Comments / Notes

FS 882 (5) HRE 98/5

BRITISH COLUMBIA

TREE ATTRIBUTES FOR WILDLIFE

Project id. | Plot no. | Surveyor

B.A.F (m^2/ha) | Plot size (m^2) | Minimum DBH (cm) | Date y m d

Tree No.	Species	Stand/Fall	DBH (cm)	M or E	Rem. Bark (%)	Length: Top (%)	Length: Bot (%)	Length: Bot pos (m)	Length: Slope Distance (m)	Estimated length (m)	Cr. Class	Height to live crown (m)	Wildlife Codes: Appear	Crown	Bark	Wood	Lichen	Wildlife use
01																		
02																		
03																		
04																		
05																		
06																		
07																		
08																		
09																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

Comments

FS 882 (6) HRE 98/5

BRITISH COLUMBIA

COARSE WOODY DEBRIS

Date y m d

Project id. | Plot no. | Surveyor

Tree No.	Transect #1 Species	Diameter (cm)	Class	Tilt Angle	Length (m)	Height of end (cm)	Angle grnd.	Transect #2 Species	Diameter (cm)	Class	Tilt Angle	Length (m)	Height of end (cm)	Angle grnd.
01														
02														
03														
04														
05														
06														
07														
08														
09														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														

Transect #1: Azimuth | (0–359) | Sampled | of 24 m

Transect #2: Azimuth | (0–359) | Sampled | of 24 m

Degree and Type of Piling (in plot boundaries)

Pile #	Size of pile (m) length	width	height	Diam (cm)	Inter. spac.
1					
2					
3					
4					
5					
6					
7					
8					

Comments

FS 882 (7) HRE 98/5

BRITISH COLUMBIA — GROUND INSPECTION FORM

G ☐ (1) V ☐	PHOTO (2)	X:	Y:	DATE (3)
PROJECT ID. (4)		SURV. (5)		
MAP SHEET (6)		PLOT # (7)		POLY. # (8)
UTM ZONE (9)	LAT. / NORTH (10)		LONG. / EAST (11)	
ASPECT (12)	°	ELEVATION (13)		m
SLOPE (14)	%	SMR (15)	SNR (16)	

MESO SLOPE POSITION (17)
☐ Crest ☐ Upper slope ☐ Mid slope ☐ Lower slope ☐ Toe ☐ Depression ☐ Level

DRAINAGE - MINERAL SOILS (18)
☐ Very rapidly ☐ Rapidly ☐ Well ☐ Mod. well ☐ Imperfectly ☐ Poorly ☐ Very poorly

MOISTURE SUBCLASSES - ORGANIC SOILS (19)
☐ Aqueous ☐ Peraquic ☐ Aquic ☐ Subaquic ☐ Perhumid ☐ Humid

MINERAL SOIL TEXTURE (20)
☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL) ☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)

ORGANIC SOIL TEXTURE (21)
☐ Fibric ☐ Mesic ☐ Humic

SURF. ORGANIC HORIZON THICKNESS (22)
☐ 0–40 cm ☐ > 40 cm

HUMUS FORM (23)
☐ Mor ☐ Moder ☐ Mull

ROOT RESTRICTING LAYER (24)
Depth _____ cm Type _____

COARSE FRAGMENT CONTENT (25)
☐ < 20% ☐ 20–35% ☐ 35–70% ☐ > 70%

TERRAIN

COMPONENT: (26) TC1 ☐ TC2 ☐ TC3 ☐

TERRAIN TEXTURE (27)	SURFICIAL MATERIAL (28)	SURFACE EXPRESSION (29)	GEOMORPH PROCESS (30)
1	1	1	1
2	2	2	2

ECOSYSTEM

COMPONENT: (31) EC1 ☐ EC2 ☐ EC3 ☐

BGC UNIT (32)		ECOSECTION (33)	
SITE SERIES (34)		SITE MODIFIERS (35)	
STRUCTURAL STAGE (36)		CROWN CLOSURE (37)	%

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2		(38)		
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		(39)
TC3		

DOMINANT / INDICATOR PLANT SPECIES

TOTAL % (44) A: B: C: D:

L. (40)	SPECIES (41)	% (42)	L.	SPECIES	%	L.	SPECIES	%

COMPLETE ☐ (43) PARTIAL ☐

Tree Mensuration (45)

Spp	DBH	Ht. Calculation to DBH: Top	Bot	SD	SL	HD	HT	Ht. to DBH	Total HT	BH Age	Path Y/N

NOTES (site diagram, exposure, gleying, etc.)

(46)

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SITE VISIT FORM

Plot No.	**Plot Type**	Grnd ☐	Visual ☐	Note ☐	Other ☐	Date YY - MM - DD
Surveyors		Map Polygon No.				Plot Photo

Plot Location

FS Region/ District	East	North	UTM Zone
NTS Map.	Lat.	Long.	Accur. (+/- m)

Plot Representing

BGC	SS	SMR	SNR	Map Label

Site Features	Elevation	Slope %	Aspect	Surface Shape	ST ☐	CC ☐	CV ☐		
Crest ☐	Upper ☐	Mid ☐	Lower ☐	Toe ☐	Level ☐	Dep. ☐	Gully ☐	Flood Plain? ☐	

Expose. Type ☐ insulation ☐ wind ☐ snow ☐ water spray ☐ misc.
☐ n/a ☐ frost ☐ cold air ☐ salt spray ☐ air toxicity _____

Site Disturb. ☐ fire ☐ site prep. ☐ terrain ☐ soil dist. _____
☐ n/a ☐ harvest ☐ planted ☐ biotic ☐ other _____

Stand Attributes | Stand Age _____ Est. ☐ Mea. ☐ | Stand Ht. _____ Est. ☐ Mea. ☐ | Canopy Composition

Struct. Stage: 1a ☐ 1b ☐ 2a ☐ 2b ☐ 2c ☐ 2d ☐ 3a ☐ 3b ☐ 4 ☐ 5 ☐ 6 ☐ 7a ☐ 7b ☐

Success Status: NV ☐ PS ☐ YS ☐ MS ☐ OS ☐ YC ☐ MC ☐ OC ☐ DC ☐

Terrain	Texture	Surficial Material	S. Expression	Geo. Process	Rock Types
1					1
2					2

Rooting Zone Drainage ☐ X ☐ R ☐ W ☐ M ☐ I ☐ P ☐ V

Humus/Organic Form ☐ Mor ☐ Moder ☐ Mull ☐ Fibric ☐ Mesic ☐ Humic

Humus Thickness _____ cm	Ah? ☐ Ae? ☐ _____ cm	Estimated Soil Depth _____ cm
R.Z. Soil Texture _____	R.Z.Coarse Fragrament % _____	Estimated Rooting Depth _____ cm
Gleying or Mottling ☐ n/a _____ cm	Seepage ☐ n/a _____ cm	Restrict.Layer ☐ n/a _____ cm

Restrict. Type ☐ **C**ement ☐ **P**an ☐ **K**ompact ☐ **L**ithic ☐ **W**ater ☐ **X** Chem. ☐ **Z** Permafrost

FS 1333 HRE 2010/03

Associated Full Cruise Card ? ☐ No ☐ Yes

SPP. LIST COL.	TREES & SHRUBS COMP. PART.	% COVER BY LAYER A1	A2	A3	TREE (A) A	SHRUB (B) B1	B2	B	HERB (C) COL.	MOSS / LICHEN (D) HERB LAYER (C)	%	COL.	MOSS / LICHEN / SEEDLING (D)	%

Notes/Diagram

Tree Mensuration

SPP.	dbh	Ht.	BH Age	Path. Y/N	Notes

FS 1333 HRE 2010/03

Appendix 3
Field Data Summary

Rescan™
Engineers and Scientists

Appendix 3. Field Data Summary

Plot Number	Field Number	ProjectID	FS Region District	Date	SiteSurveyor	UTM Zone	UTM Easting	UTM Northing	Zone	SubZone	Site Series	Trans Distrib	Realm Class	Moisture Regime	Nutrient Regime	Successional Status	Structural Stage	Stand Age	Elevation	Slope Gradient	Aspect	Meso Slope Position	Surface Shape
028		Brucejack 2012	PR	8/14/2012	McAllister, Bush	9	425739	6258919	AT					2	B		2d		1347	25	240	UP	
029		Brucejack 2012	PR	8/14/2012	McAllister, Bush	9	425662	6258860	AT					2	A		2d		1339	15	310	CR	
08-9410		Brucejack 2012	PR	8/12/2012	McAllister, Bush	9	435044	6217622	MH	mm1	01			3	C	MC	7a	300	685	71	260	MD	CV
08-9411		Brucejack 2012	PR	8/13/2012	McAllister, Bush	9	435087	6216159	MH	mm2	01			3	C	MC	7a	300	567	55	240	MD	CV
12-7002		Brucejack 2012	PR	6/25/2012	Glavas, Blashill	9	451730	6263630	ICH	vc	03			6	C		6		612	24	203	LW	CV
12-7003		Brucejack 2012	PR	5/6/2012	Glavas, Blashill	9	468856	6259032	ICH	vc	01			4	C		3/b		641	6	350	MD	CV
12-7004		Brucejack 2012	PR	6/25/2012	Glavas, Blashill	9	468512	6259679	ICH	vc	03			6	D		7		648	5	232	LW	CV
12-7005		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468689	6260218	ICH	vc	01			4	C		3a		650	18	94	MD	ST
12-7006		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468052	6261987	ICH	vc	02(1)			3	B		6		679			CR	ST
12-7007		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468770	6263405	ICH	vc	00			6	D		3b		584	22	322	LW	ST
12-7008		Brucejack 2012	PR	6/28/2012	Durand	9	451041	6263311	ICH	vc			Fl	7	C		3a		609	1	999	LV	ST
12-7009		Brucejack 2012	PR	6/28/2012	Glavas, McAllister, Durand, Blashill	9	451132	6263482	ICH	vc				7	C		3a		604	1	999	LV	ST
12-7010		Brucejack 2012	PR	6/28/2012	Glavas, McAllister, Durand, Blashill	9	452962	6264344	ESSF	wv				7	B		2b		874	0	999	LV	ST
12-7012		Brucejack 2012	PR	6/28/2012	Glavas, Blashill	9	469691	6263798	ICH	vc	04			5	D		6		457	0	999	LV	ST
12-7013		Brucejack 2012	PR	6/29/2012	Glavas, Blashill, McAllister	9	469984	6264026	ICH	vc	01(2)			4	B		6		466	3	208	MD	ST
12-7014		Brucejack 2012	PR	6/29/2012	Blashill, Glavas	9	470107	6264862	ICH	vc	02(2)			3	B		5		594	33	228	UP	CV
12-7015		Brucejack 2012	PR	6/29/2012	Glavas, Blashill, McAllister	9	469629	6264186	ICH	vc	04			6	D		6		469	5	246	TO	CV
12-7016		Brucejack 2012	PR	6/30/2012	Glavas, Blashill, McAllister	9	465728	6263697	ICH	vc	01(1)	1		4	C	MC	7		769	15	116	MD	ST
12-7017		Brucejack 2012	PR	1/7/2012	Glavas, Blashill, McAllister	9	455191	6252230	ICH	vc				5	B		5		374	0	999	LV	ST
12-7018		Brucejack 2012	PR	7/1/2012	Glavas, Blashill, McAllister	9	453218	6252834	ICH	vc	05	1	Fm	5	D	MEC	6/m		392	0	999	LV	CC
12-7019		Brucejack 2012	PR	2/7/2012	Glavas, Blashill	9	452287	6258043	ICH	vc	03b						6		618	45	98	MD	CV
12-7020		Brucejack 2012	PR	3/7/2012	Glavas, Blashill	9	449350	6250464	ICH	vc	02(1)			2	B		6		399		999	LV	ST
12-7021		Brucejack 2012	PR	4/7/2012	Glavas, Blashill	9	472329	6258219	ICH	vc	02(1)			3	B		6		761	10	256	CR	CV
12-7105		Brucejack 2012	PR	8/15/2012	McAllister, Bush, Tait	9	426364	6260376	AT		00	1		5	C	MC	2d		1492	10	160	LW	ST
12-7106		Brucejack 2012	PR	8/15/2012	McAllister, Bush, Tait	9	426409	6260312	CMA		00	1	Wf	6	D	MC	2b		1488	9	160	LW	ST
12-7108		Brucejack 2012	PR	8/17/2012	McAllister, Bush, Tait	9	455975	6262995	ESSF	wv	00	4		4	D		7		990	160	240	LW	CC
12-7137		Brucejack 2012	PR	8/15/2012	McAllister, Bush	9	426423	6258807	AT		00		At	2	B		2d		1390	30	28	UP	CV
12-7138	BJ015	Brucejack 2012	PR	8/15/2012	McAllister, Bush, Tait	9	426894	6258785	CMA		00		At										
12-7139		Brucejack 2012	PR	8/15/2012	McAllister, Bush	9	426250	6260834	CMA		At	1	Af	3	C		2d		1688	15	180	UP	CV
12-7162		Brucejack 2012	PR	8/17/2012	McAllister, Bush, Tait	9	459391	6264963	ESSF	fwv	01		up			MC	7b		984	25	190	UP	CV
12-7165		Brucejack 2012	PR	8/18/2012	McAllister, Bush, Tait	9	436503	6249115	ICH	vc	02(2)			2	C	MS	6	120	619	60	344	MD	ST
12-7166		Brucejack 2012	PR	8/19/2012	McAllister, Bush	9	452118	6260024	ESSF	wv	1	1		3	C	MS	6		744	55	340	MD	ST
12-7167		Brucejack 2012	PR	8/19/2012	NB, BT, DM	9	450441	6260702	ESSF	wv	01			4	C	MS	6	150	716	10	230	LW	ST
12-7168		Brucejack 2012	PR	8/19/2012	McAllister, Bush, Tait	9	452690	6261576	ESSF	wv	05			5	D	MC	7a	200	673	6	320	LW	CC
12-7169		Brucejack 2012	PR	8/19/2012	McAllister, Bush, Tait	9	445738	6249799	ICH	vc	swFp				2		6	250	419			LV	ST
12-7170		Brucejack 2012	PR	8/21/2012	McAllister, Bush	9	435745	6214115	CWH	ww	09	4		6	D	MC	7b	400	402	4	118	LW	CC
12-7200		Brucejack 2012	PR	8/10/2012	McAllister, Bush	9	434868	6222861	MH	unp	02			2	C	YC	7		1010	80	200	MD	ST
12-7922		Brucejack 2012	PR	5/7/2012	Glavas, Blashill	9	452776	6262351	ICH	vc	05			5	B		6		616	0		LV	ST
BJ001		Brucejack 2012	PR	8/8/2012	McAllister, Bush	9	434623	6237503	ESSF	wv	AB/DH			2	A	PS	3b		641	3	242	LV	ST
BJ002		Brucejack 2012	PR	8/9/2012	McAllister, Bush	9	434749	6237240	ESSF	vc	ws			5	D	PS	3b		641			LV	ST
BJ003		Brucejack 2012	PR	8/10/2012	McAllister, Bush	9	434781	6225635	MH	mm1	KR			2	D	DC	2d		1138	50	260	CR	CV
BJ004		Brucejack 2012	PR	8/10/2012	McAllister, Bush	9	435021	6227835	MH	mm1	01			3	C	OS	7a		927	15		MD	CV
BJ005		Brucejack 2012	PR	8/11/2012	McAllister, Bush	9	433574	6230234	MH	mm1	Am			2	C	DC	2a		921	68	215	MD	CC
BJ006		Brucejack 2012	PR	8/11/2012	McAllister, Bush	9	433014	6233247	MH	mmp	TI			2	B	DC	3a			45	300	MD	CV
BJ007		Brucejack 2012	PR	8/11/2012	McAllister, Bush	9	434811	6222335	MH	mm1	01			2	C	MS	7a	300	975	65	310	MD	CV
BJ008		Brucejack 2012	PR	8/11/2012	McAllister, Bush	9	435509	6219834	MH	mm1	01			4	C				834	60	264	MD	
BJ009		Brucejack 2012	PR	8/12/2012	McAllister, Bush	9	435099	6215676	MH	mm1	01			4	C	MC	7a		528	40	318	MD	CC
BJ010		Brucejack 2012	PR	8/12/2012	McAllister, Bush	9	435039	6216913	MH	mm1	01			3	C	MC	7a	300	662	75	284	MD	ST
BJ011		Brucejack 2012	PR	8/13/2012	McAllister, Bush	9	435004	6215219	CWH	wm1	01			4	C	MC	7a	250	524	80	268	MD	ST
BJ012		Brucejack 2012	PR	8/14/2012	McAllister, Bush	9	426166	6258940	AT		Af			5	D		2b		1349	5	210	LV	ST
BJ013		Brucejack 2012	PR	12/8/2014	McAllister, Bush	9	425662	62588	AT		At												
BJ014		Brucejack 2012	PR	8/12/2012	McAllister, Bush, Tait	9	425991	6259142	AT		At, Aw, Ah, Am, BA			5	C		2d		1371			DP	
BJ015		Brucejack 2012	PR	8/15/2012	McAllister, Bush	9	426894	6258785	CMA		At			2	B		2d		1365				
BJ016		Brucejack 2012	PR	8/16/2012	NB, BT, DM	9	439879	6250741	ICH		02			2	B	YS	4	30	471	60	260	LW	ST
BJ017		Brucejack 2012	PR	8/16/2012	McAllister, Bush, Tait	9	439797	6250697	ICH	vc	02			2	B	YS	4	30	460			LV	
BJ018		Brucejack 2012	PR	8/16/2012	McAllister, Bush, Tait	9	443244	6250744	ICH	vc	02			2	B	YS	3b	20	440			LV	ST
BJ019		Brucejack 2012	PR	8/16/2012	McAllister, Bush, Tait	9	444536	6250722	ICH	vc	02			2	C	MS	5		431			LV	ST
BJ020		Brucejack 2012	PR	8/10/2012	McAllister, Bush, Tait	9	447285	6249718	ICH	vc	02			3	C	YS	4	60	444	65	108	MD	CV
BJ021		Brucejack 2012	PR	8/17/2012	McAllister, Bush, Tait	9	461900	6263617	ESSF	wv	01			3	C	MC	7b	300	966		60	MD	ST

Appendix 3. Field Data Summary

Plot Number	Field Number	ProjectID	FS Region District	Date	SiteSurveyor	UTM Zone	UTM Easting	UTM Northing	Zone	SubZone	Site Series	Trans Distrib	Realm Class	Moisture Regime	Nutrient Regime	Successional Status	Structural Stage	Stand Age	Elevation	Slope Gradient	Aspect	Meso Slope Position	Surface Shape
BJ022		Brucejack 2012	PR	8/15/2012	McAllister, Bush	9	459334	6263540	ESSF	wv	05												
BJ022		Brucejack 2012	PR	8/17/2012	McAllister, Bush	9	459334	6263540	ESSF	wv	05			j	D	MC	7b	300	979	18	140	MD	
BJ023		Brucejack 2012	PR	8/16/2012	NB, BT, DM	9	459135	6263556	ESSF	wv	wf08			6	C		2b		969	8	160	LV	ST
BJ024		Brucejack 2012	PR	8/17/2012	McAllister, Bush, Tait	9	457423	6263537	ESSF	wv	04			2	B	DC	4		996			CR	CV
BJ025		Brucejack 2012	PR	8/17/2012	McAllister, Bush, Tait	9	457297	6263576	ESSF	wv	04			3	B	MC	7b	300	1006			UP	CV
BJ026		Brucejack 2012	PR	8/18/2012	McAllister, Bush, Tait	9	433897	6241802	ICH	vc	AT			3	B	PS	3b	30	706			MD	CC
BJ027		Brucejack 2012	PR	8/18/2012	McAllister, Bush, Tait	9	433765	6241889	ICH	vc	At			3	C				655	42	310		ST
BJ028		Brucejack 2012	PR	8/18/2012	McAllister, Bush, Tait	9	434572	6243464	ESSF	vc	P			2	B	DC	5		783	55	250	UP	CV
BJ029		Brucejack 2012	PR	8/18/2012	McAllister, Bush, Tait	9	434566	6247319	ICH	vc	02			2	B	YS	4	35	529			MD	
BJ030		Brucejack 2012	PR	8/18/2012	McAllister, Bush, Tait	9	437021	6250602	ICH	02x	2			B		PS	3a	40	529			LV	ST
BJ031		Brucejack 2012	PR	8/19/2012	McAllister, Bush, Tait	9	438196	6251196	ICH	vc	AT			4	C	YS	3b	30				LW	ST
BJ032		Brucejack 2012	PR	8/21/2012	McAllister, Bush	9	435980	6214466	CWH	wm	01			4	C	MC	7b	400	357	25	170	LW	CC
BJ033		Brucejack 2012	PR	8/21/2012	McAllister, Bush	9	435376	6214328	CWH	wm	08			5	B	OG	7b	300	450	12	270	LW	CC
BJ034		Brucejack 2012	PR	8/21/2012	McAllister, Bush	9	435736	6214149	CWH	wm	02			2	B	OG	7b	400	410	60	192	MD	ST
K001		Brucejack 2012	PR	6/25/2012	Glavas, Blashill	9	451692	6263473											599	0	999		ST
K002	12-7002	Brucejack 2012	PR	6/25/2012	Glavas, Blashill	9	451730	6263630	ICH	vc	03			6	C		6		612	24	203	LW	CV
K003	12-7003	Brucejack 2012	PR	6/5/2012	Glavas, Blashill	9	468856	6259032	ICH	vc	01			4	C		3b		641	6	350	MD	CV
K004		Brucejack 2012	PR	6/26/2012	Blashill, Glavas	9	468721	6259228											635			LV	
K005	12-7004	Brucejack 2012	PR	6/25/2012	Glavas, Blashill	9	468512	6259679	ICH	vc	03			b	D		7		648	5	232	LV	CV
K006		Brucejack 2012	PR	6/12/2026	Glavas, Blashill	9	468624	6259491															
K007		Brucejack 2012	PR	6/12/2026	Glavas, Blashill	9	468951	6259301	ICH	vc	03			6	D		7a			25	219	UP	CV
K008		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468840	6259897	ICH		03			5	D				656	10	184	LW	CC
K009	12-7005	Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468589	6260218	ICH	vc	01			4	C		3a		650	8	94	MD	ST
K010		Brucejack 2012	PR	6/12/2026	Glavas, Blashill	9	468134	6261288	ICH	vc	01			4	D				882	10	106	UP	CV
K012	12-7006	Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468052	6261987	ICH	vc	02(i)			3	B		6		679			CR	ST
K013		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468651	6262104	Ich	vc	03						3b		682				
K014		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468922	6262548	ICH	vc	51												
K015		Brucejack 2012	PR	6/26/2012	Glavas, Blashill	9	468994	6263381	ICH	vc	02(1)			3	B				636				
K016	12-7007	Brucejack 2012	PR	6/26/2012	Glavas/Blashill	9	468770	6263405	ICH	vc	51			6	D		3b		584	22	322	LW	ST
K017		Brucejack 2012	PR	6/26/2012	Blashill, Glavas	9	468384	6263954															
K018		Brucejack 2012	PR	6/26/2012	Blashill, Glavas	9	466965	6259981	ICH	vc	01			4	C				685	6	178	MD	CV
K019		Brucejack 2012	PR	6/27/2012	Glavas, Blashill	9	466758	6260584	ICH	vc	03			5	D				653			LW	
K020		Brucejack 2012	PR	6/27/2012	Glavas, Blashill	9	466880	6260680	ICH	vc	03			5	D		6		635			LW	
K021		Brucejack 2012	PR	6/27/2012	Blashill, Glavas	9	466175	6260687	ICH	vc	01			4	C				709	25	50	UP	CV
K022		Brucejack 2012	PR	6/27/2012	Blashill, Glavas	9	466076	6261152	ICH	vc	06			6	D		5		700	8	172		ST
K023		Brucejack 2012	PR	6/27/2012	Glavas, Blashill	9	465623	6262014	ICH	vc	WH			7	D		2a		733	0		DP	
K024		Brucejack 2012	PR	6/27/2012	Glavas, Blashill	9	464895	6262443	ICH	vc	02(1)			3	C		6		756	10	56	LW	CC
K025		Brucejack 2012	PR	6/27/2012	Glavas, Blashill	9	464483	6262895	ICH	vc	02(1)			2	B		6		746	58	350	UP	ST
K026	12-7008	Brucejack 2012	PR	6/28/2012	Durand	9	451041	6263311	ICH	vc			Fl	7	C		3a		109	1	352	LV	ST
K027	12-7009	Brucejack 2012	PR	6/28/2012	Glavas, DM, WB, RB	9	451132	6263482	ICH	vc				vm	C		3a		604	1	300	LV	ST
K028	12-7010	Brucejack 2012	PR	6/28/2012	Glavas, Blashill, McAllister, Durand	9	452962	6264344	ESSF	wv	Wf03			W	B		2b		874	0	999	LV	ST
K029		Brucejack 2012	PR	6/28/2012	Glavas/McAllister	9	453015	6264337	ESSF	wv	03			2	C	MC	7a	250	878	14	268	UP	
K030		Brucejack 2012	PR	6/28/2012	Glavas, Blashill, McAllister	9	453134	6264835	ESSF	wv	WF13			6	B	DC	2b		836			TO	CV
K031	12-7012	Brucejack 2012	PR	6/28/2012	Glavas/Blashill	9	469691	6263798	ICH	vc	04			5	D		6		457	0	999	LV	ST
K032	12-7013	Brucejack 2012	PR	6/29/2012	Glavas, Blashill, McAllister	9	469984	6264026	ICH	vc	01(2)			4	B		6	102	466	3	208	MD	ST
K033	12-7014	Brucejack 2012	PR	6/29/2012	Blashill, Glavas	9	470107	6264862	ICH	vc	02(2)			3	B		5		594	33	225	UP	CV
K040		Brucejack 2012	PR	6/29/2012	Glavas, Blashill	9	469791	6264625	ICH	vc	03			5	D	MC	6		523	12	236		
K041	12-7015	Brucejack 2012	PR	6/29/2012	Glavas, Blashill, McAllister	9	469629	6264186	ICH	vc	04			6	D		6	124	469	5	246	TO	CV
K042		Brucejack 2012	PR	6/30/2012	Blashill, Glavas	9	464008	6263854	ESSF	wv	05			5	D	OG	7b		894	18	159		
K043		Brucejack 2012	PR	6/30/2012	Glavas, Blashill, McAllister	9	464292	6263500	ICH	vc	01			4	C		7a		821	28	198	MD	ST
K044		Brucejack 2012	PR	6/30/2012	Blashill, Glavas	9	465183	6263599	ICH	vc	02			3	B		5	300	815	19	94	MD	
K045	12-7016	Brucejack 2012	PR	6/30/2012	Glavas, Blashill, McAllister	9	465728	6263697	ICH	vc	01(1)	001		4	C	MC	7a	300	769	15	116	MD	ST
K046		Brucejack 2012	PR	6/30/2012	Glavas, Blashill, McAllister	9	467403	6263664											555	8	110		
K047		Brucejack 2012	PR	7/1/2012	Glavas, Blashill, McAllister	9	455825	6252243	ICH	vc	F1D4			5	C		4		371	0	999	LV	
K048		Brucejack 2012	PR	7/1/2012	Glavas, Blashill, McAllister	9	455698	6252257	ICH	vc	FM			2	A		2d		372	0	999	LV	ST
K049	12-7017	Brucejack 2012	PR	7/1/2012	Glavas, Blashill, McAllister	9	455191	6262230	ICH	vc	Fm 02			5	B		5		374	0	999	LV	ST
K050		Brucejack 2012	PR	7/1/2012	Blashill, Glavas	9	454006	6252722	ICH	vc	FM			2	B		3b		383	0	999		
K051	12-7018	Brucejack 2012	PR	7/1/2012	Glavas, Blashill, McAllister	9	453218	6252834	ICH	vc	05		Fm	5	D	MC	6		392	4	118		ST
K052		Brucejack 2012	PR	7/2/2012	Glavas, Blashill	9	452189	6259190	ICH	vc	02(1)			3	B		5		731	17	344	UP	

Appendix 3. Field Data Summary

Plot Number	Field Number	ProjectID	FS Region District	Date	SiteSurveyor	UTM Zone	UTM Easting	UTM Northing	Zone	SubZone	Site Series	Trans Distrib	Realm Class	Moisture Regime	Nutrient Regime	Successional Status	Structural Stage	Stand Age	Elevation	Slope Gradient	Aspect	Meso Slope Position	Surface Shape
K053		Brucejack 2012	PR	7/2/2012	Glavas, Blashill	9	452058	6258695	ICH	vc	02(2)			3	D		5		713	3	72	UP	
K054		Brucejack 2012	PR	7/2/2012	Glavas, Blashill	9	452002	6258194	ICH	vc	01(2)						6		662	12	150	MD	
K055	12-7019	Brucejack 2012	PR	7/2/2012	Glavas, Blashill	9	452287	6258043	ICH	vc	3b			4	C		6		618	45	98	MD	CV
K056		Brucejack 2012	PR	7/3/2012	Glavas, Blashill	9	453274	6253959	ICH	vc	)3b			5	C				539	37	150	MD	ST
K057		Brucejack 2012	PR	7/3/2012	Glavas, Blashill	9	452838	6253322	ICH	vc	05			5	D				401	0		LV	
K058	12-7020	Brucejack 2012	PR	7/3/2012	Glavas, Blashill	9	449350	6250465	ICH	vc	02(i)			2	B		6		399	0	999	LV	ST
K059		Brucejack 2012	PR	7/3/2012	Glavas, Blashill	9	452129	6252062	ICH	vc	05			6	D		6		384	0		LV	
K060		Brucejack 2012	PR	7/4/2012	Glavas, Blashill	9	470456	6263818	ICH	vc	04			6	D		6		414	3	116	LV	ST
K061		Brucejack 2012	PR	7/4/2012	Blashill, Glavas	9	472659	6261641	ICH	vc	Fl						3b		424	0			
K062		Brucejack 2012	PR	7/4/2012	Glavas, Blashill	9			ICH	vc	FM			6	C		6					LV	
K063		Brucejack 2012	PR	7/4/2012	Glavas, Blashill	9	474917	6259011	ICH	vc	06			6	D		6		417			LV	ST
K064		Brucejack 2012	PR	7/4/2012	Glavas, Blashill	9	473320	6258512	ICH	vc	02(1)			2	B		6		904	2	340		ST
K065	12-7021	Brucejack 2012	PR	7/4/2012	Glavas, Blashill	9	472329	6258219	ICH	vc	02(1)			3	B		6		761	10	256	CR	CV
K066	12-7022	Brucejack 2012	PR	7/5/2012	Glavas, Blashill	9	452776	6262351	ICH	vc	5			5	B		6		616	0		LV	ST
K067		Brucejack 2012	PR	7/5/2012	Glavas, Blashill	9	452942	6262094	ICH	vc	03b			5	D		6					LW	
K068		Brucejack 2012	PR	7/5/2012	Glavas, Blashill	9	451181	6266236	ICH	vc	0b			6	D				591	0		LV	ST
K069		Brucejack 2012	PR	7/5/2012	Glavas, Blashill	9	450904	6266259	ICH	vc	01(2)			4	C		6		597	0		LW	
K070		Brucejack 2012	PR	7/5/2012	Glavas, Blashill	9	450908	6265869	ICH	vc	06			6	D		5		100	0	5	LV	
K071		Brucejack 2012	PR	7/5/2012	Glavas, Blashill	9	450577	6265722	ICH	vc	03b			5	D		6					LW	ST
K072		Brucejack 2012	PR	7/6/2012	Glavas, Blashill	9	466360	6263445	ICH	vc	52			6	D		3b		678	30	106	MD	CV
KG039		Brucejack 2012	PR	7/6/2012	Glavas, Blashill	9	467656	6263829	ICH	vc	03b			5	D				575				
KG040		Brucejack 2012	PR	7/6/2012	Glavas, Blashill	9	468064	6263732	ICH	vc	04			6	D		6		468				
V030		Brucejack 2012	PR	8/8/2012	McAllister, Bush	9	425201	6258785	AT		alpin			3	C				1334	20	310	CR	CV

Appendix 4
PEM Maps

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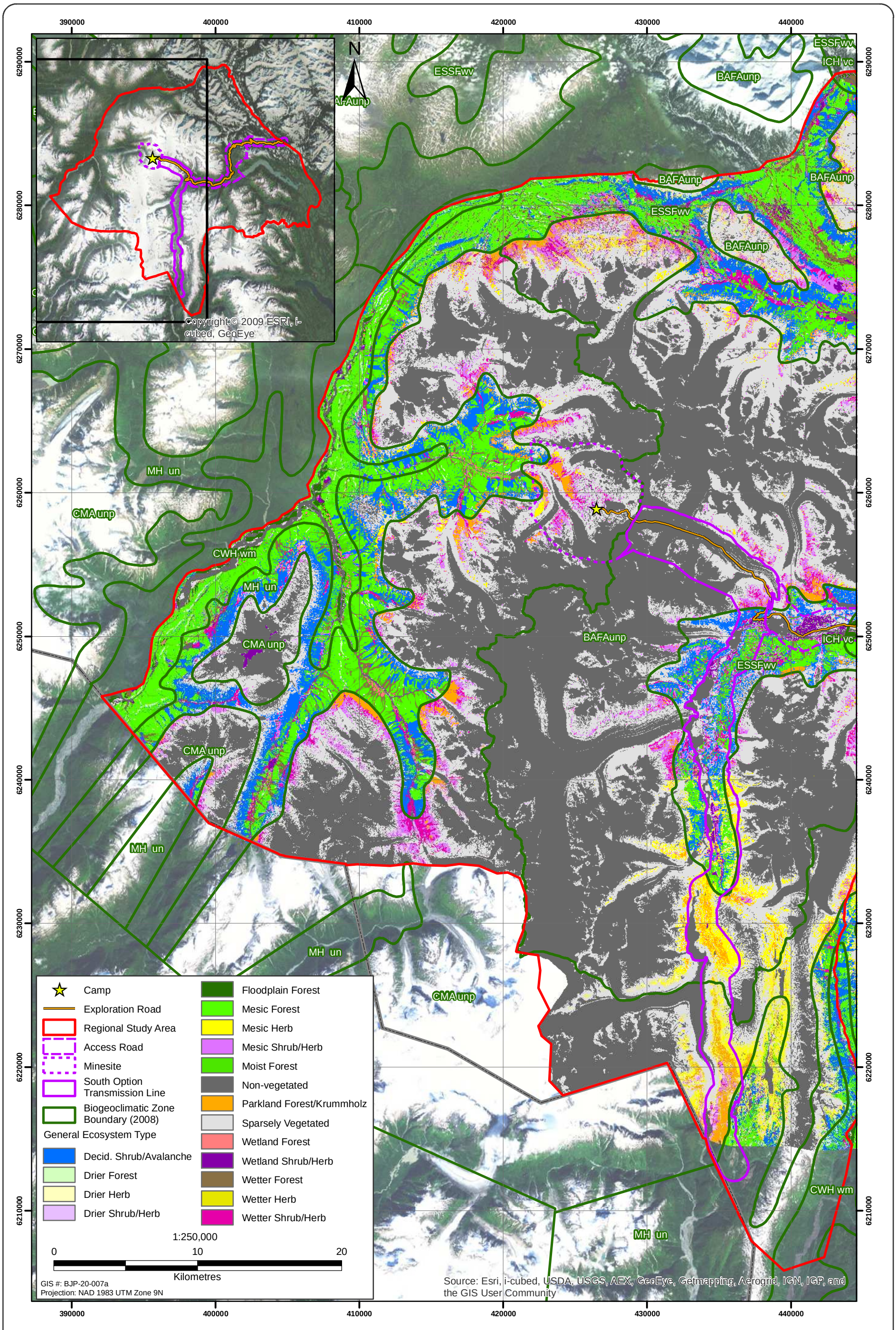
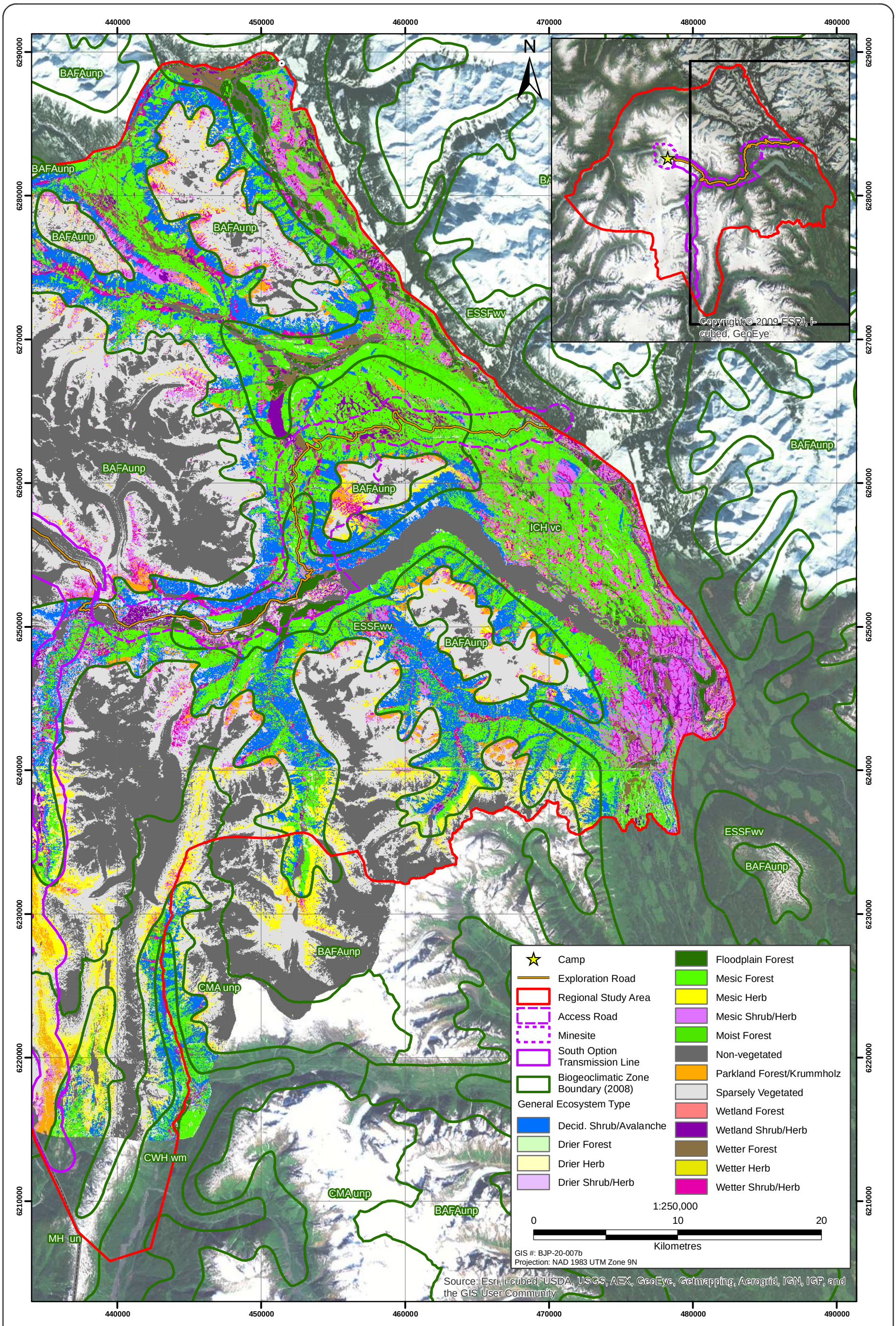


PRETIVM

Distribution of General Ecosystem Types in the Regional Study Area - Map 1

Rescan™ Engineers & Scientists



Appendix 4

PRETIVM

Distribution of General Ecosystem Types in the Regional Study Area - Map 2

Appendix 4

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Appendix 5
Terrain Maps

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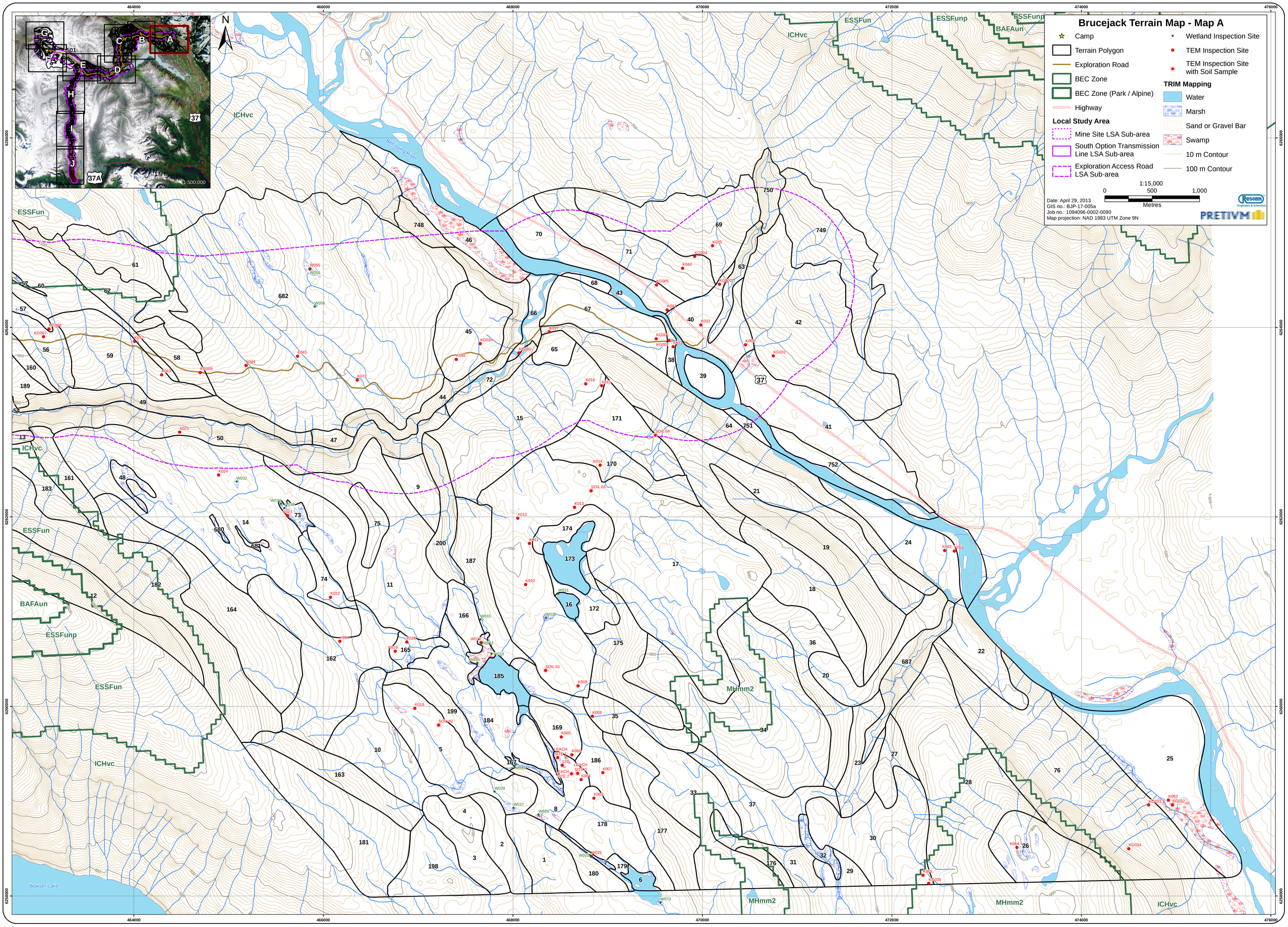
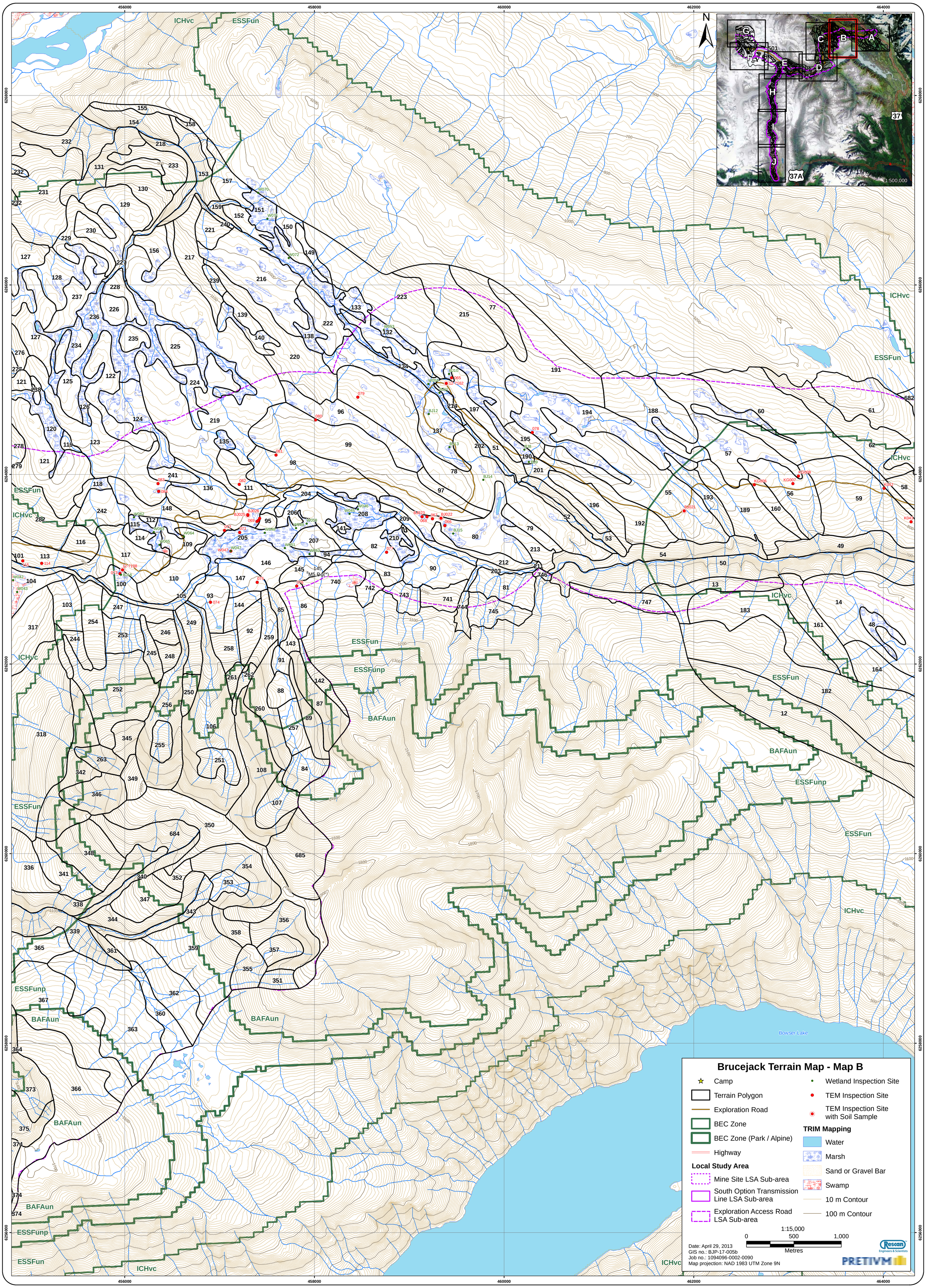
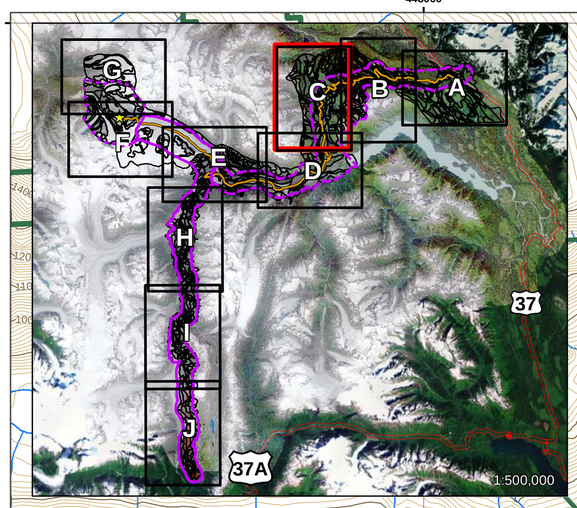


Brucejack Terrain Map - Map A
Camp
Terrain Polygon
Exploration Road
BEC Zone
BEC Zone (Park / Alpine)
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-17-005a
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
Rescan
PRETIVM
N
1:500,000
Bell-Irving River
Bowser Lake
ICHvc
ESSFun
ESSFunp
BAFAun
MHmm2


456000
458000
460000
462000
464000
6266000
6264000
6262000
6260000
6258000
6256000
N
ICHvc
ESSFun
ESSFunp
BAFAun
Bowser Lake
A
B
C
D
E
F
G
H
I
J
501
37
37A
1:500,000
Brucejack Terrain Map - Map B
Camp
Terrain Polygon
Exploration Road
BEC Zone
BEC Zone (Park / Alpine)
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-17-005b
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
Rescan
Engineers & Scientists
PRETIVM



Brucejack Terrain Map - Map C

- Camp
- Terrain_Mapping
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000
0 500 1,000
Metres

Date: April 29, 2013
GIS no.: BJP-17-005c
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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Brucejack Terrain Map - Map D

- Camp
- Terrain Polygon
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-17-005d
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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PRETIVM

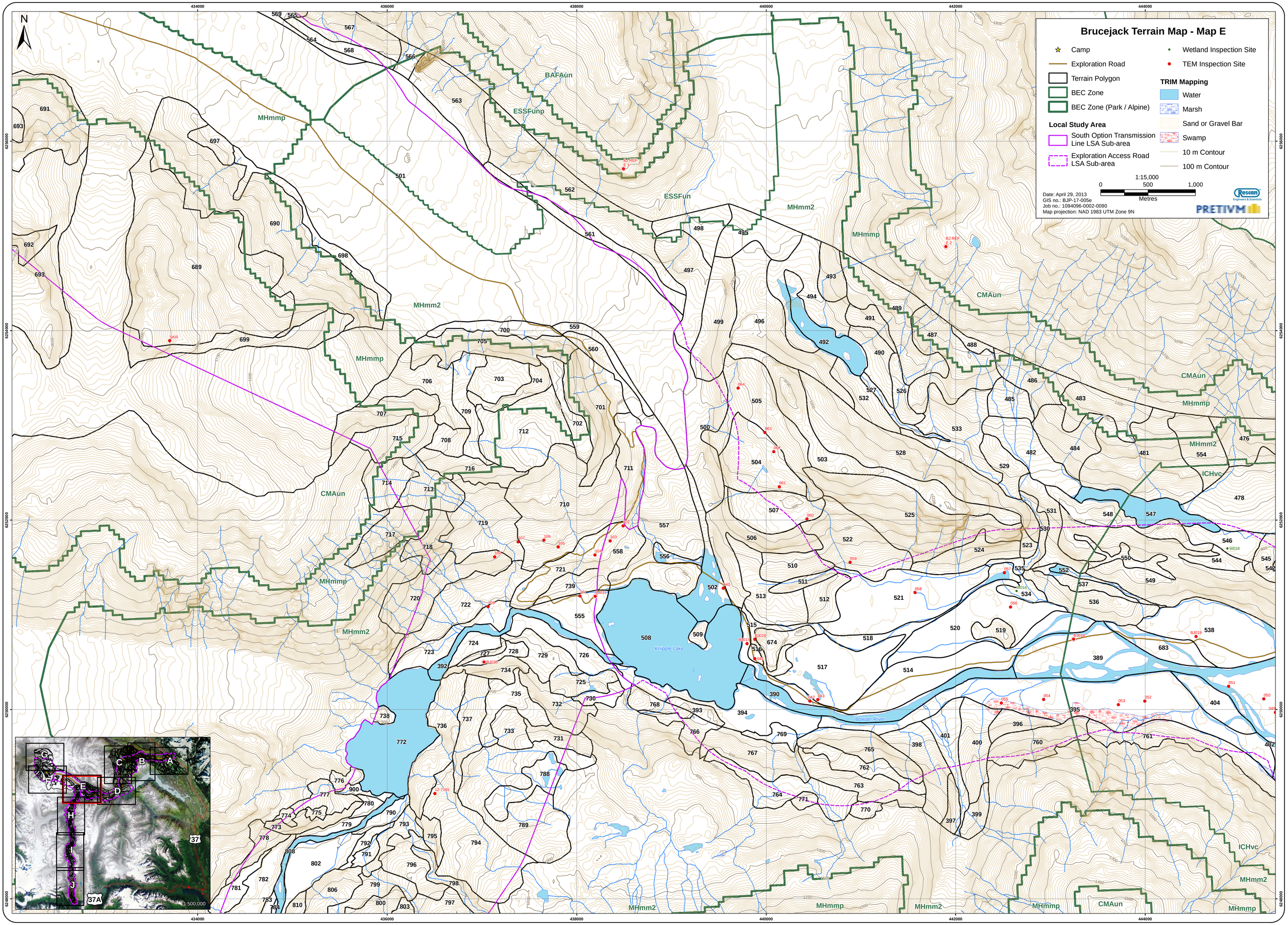
N

1:500,000

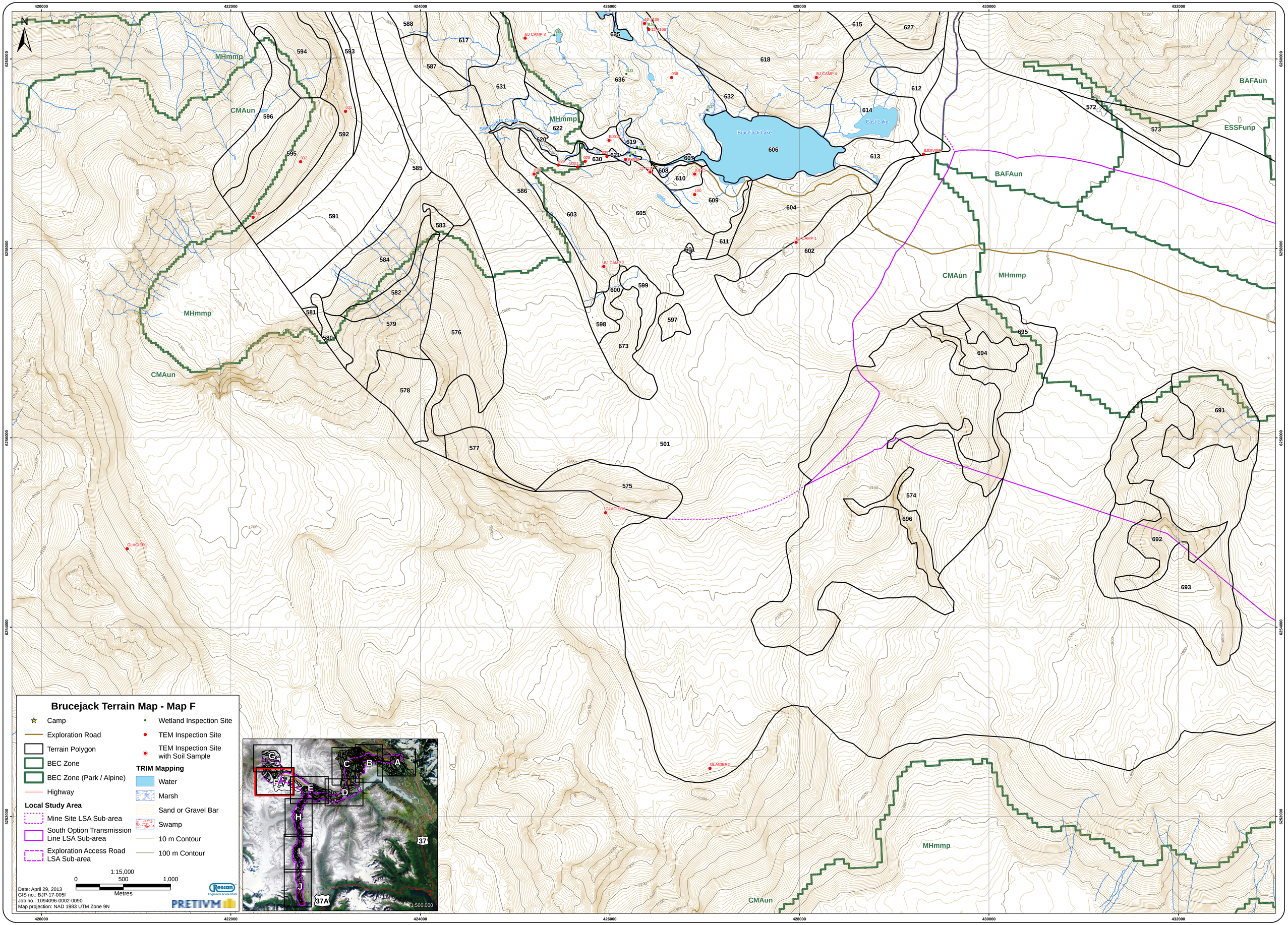
Bowser Lake

Bowser River

BAFAun ESSFunp ESSFun ICHvc CMAun MHmm2 MHmmp



Brucejack Terrain Map - Map E
Camp
Exploration Road
Terrain Polygon
BEC Zone
BEC Zone (Park / Alpine)
Local Study Area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-17-005e
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
Rescan Engineers & Scientists
PRETIVM
N
BAFAun
ESSFunp
ESSFun
MHmmp
MHmm2
CMAun
ICHvc
Knipple Lake
Bowser River
1:500,000



Brucejack Terrain Map - Map F
Camp
Exploration Road
Terrain Polygon
BEC Zone
BEC Zone (Park / Alpine)
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-17-005f
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
Rescan
Engineers & Scientists
PRETIVM
Brucejack Lake
East Lake
Southwest Creek
MHmmp
CMAun
BAFAun
ESSFunp
GLACIER1
GLACIER2
GLACIER3
BJ CAMP 1
BJ CAMP 2
BJ CAMP 3
BJ CAMP 4
1:500,000

Brucejack Terrain Map - Map G

- Camp
- Exploration Road
- Terrain Polygon
- BEC Zone
- BEC Zone (Park / Alpine)
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000
0 500 1,000
Metres

Date: April 29, 2013
GIS no.: BJP-17-005g
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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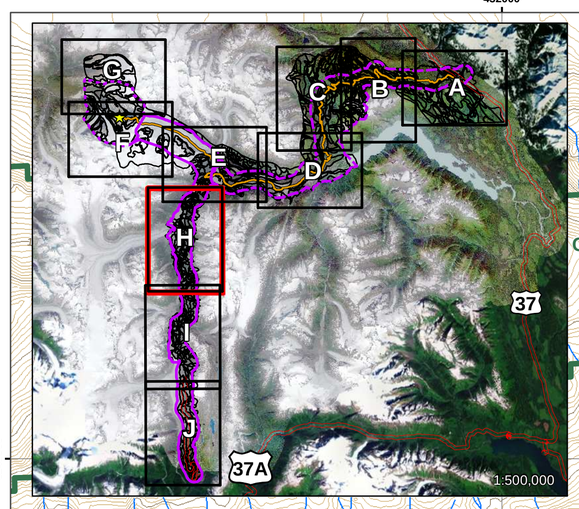
PRETIVM

1:500,000

Brucejack Terrain Map - Map H



N

Bowser River

BJ REF SOUTH

12-7165

BJ029 099 BJ028 097 096 095 094 093 092 091 090 089 BJ027 BJ0261 088 087 GRIZPRINT 085 BJ002 BJ001 098

MHmm2 MHmmp CMAun

Legend

- Camp
- Exploration Road
- Terrain Polygon
- BEC Zone
- BEC Zone (Park / Alpine)
- Soil Polygon Boundary
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-17-005h
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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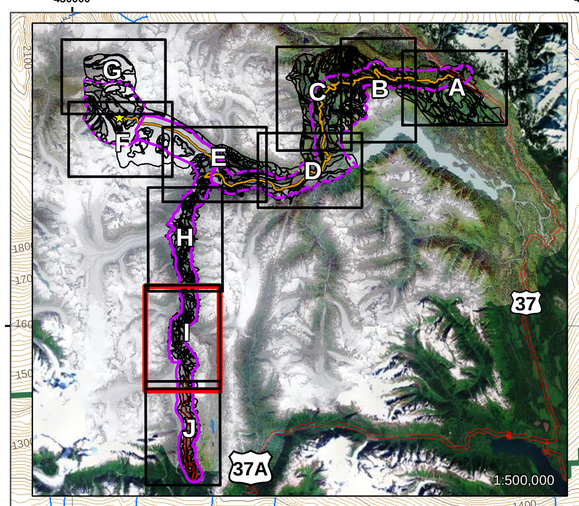
Brucejack Terrain Map - Map I



- Camp
- Exploration Road
- Terrain Polygon
- BEC Zone
- BEC Zone (Park / Alpine)
- Soil Polygon Boundary
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-17-005i
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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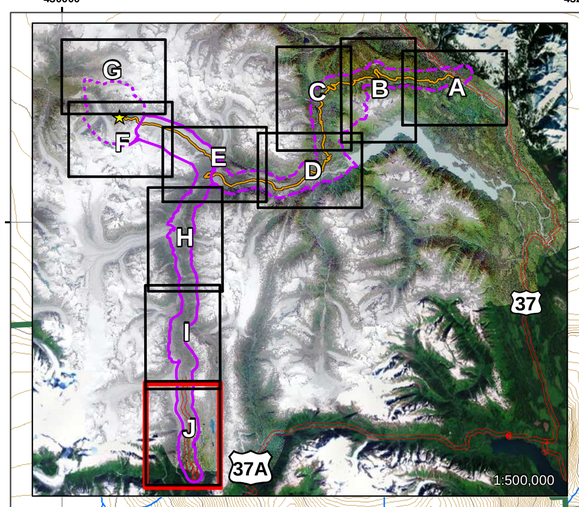
PRETIVM



Brucejack Terrain Map - Map J

- Camp
- Exploration Road
- Terrain Polygon
- BEC Zone
- BEC Zone (Park / Alpine)
- Soil Polygon Boundary
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000
0 500 1,000
Metres

Date: April 29, 2013
GIS no.: BJP-17-005j
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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Appendix 6
TEM Maps

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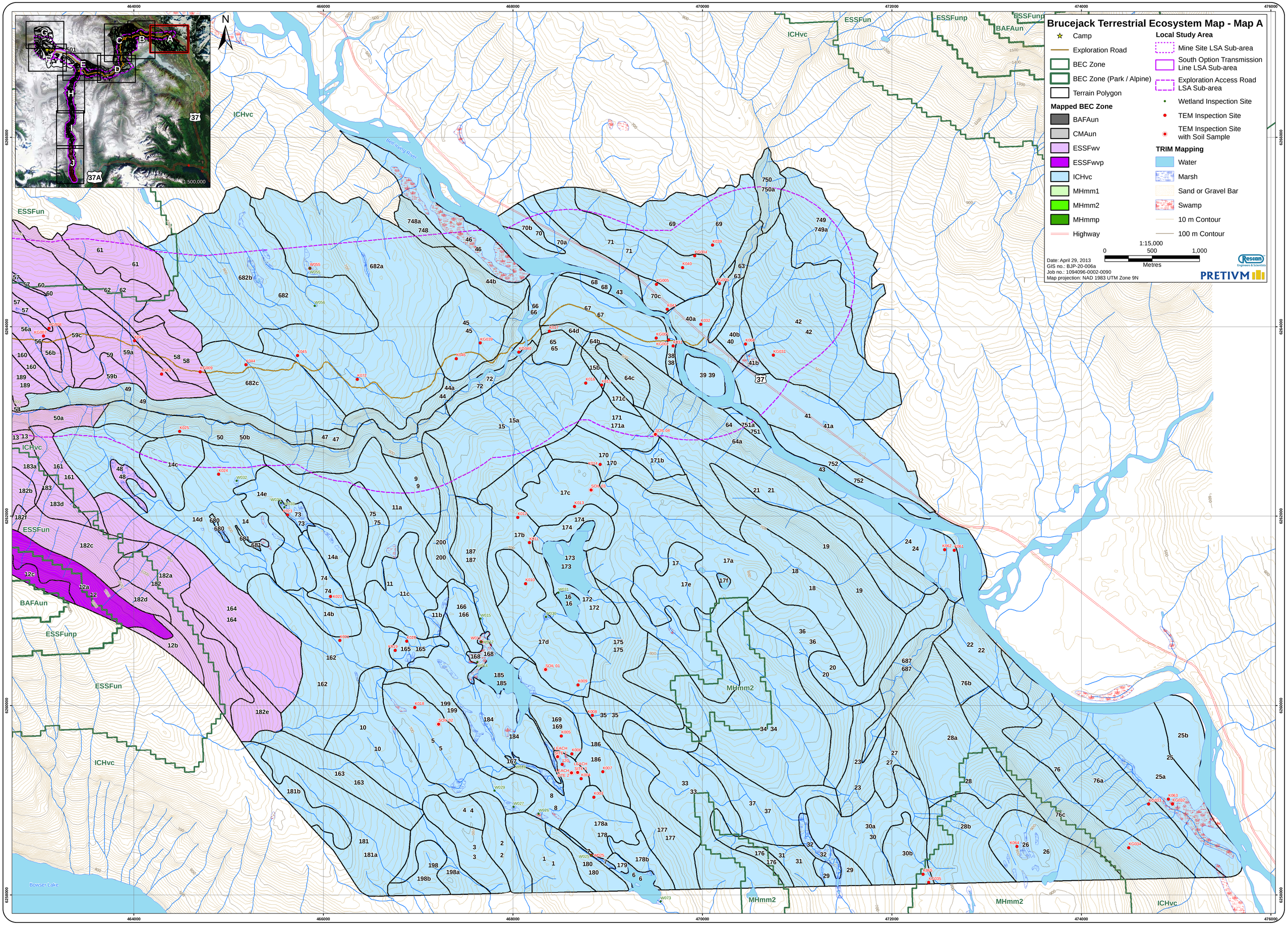
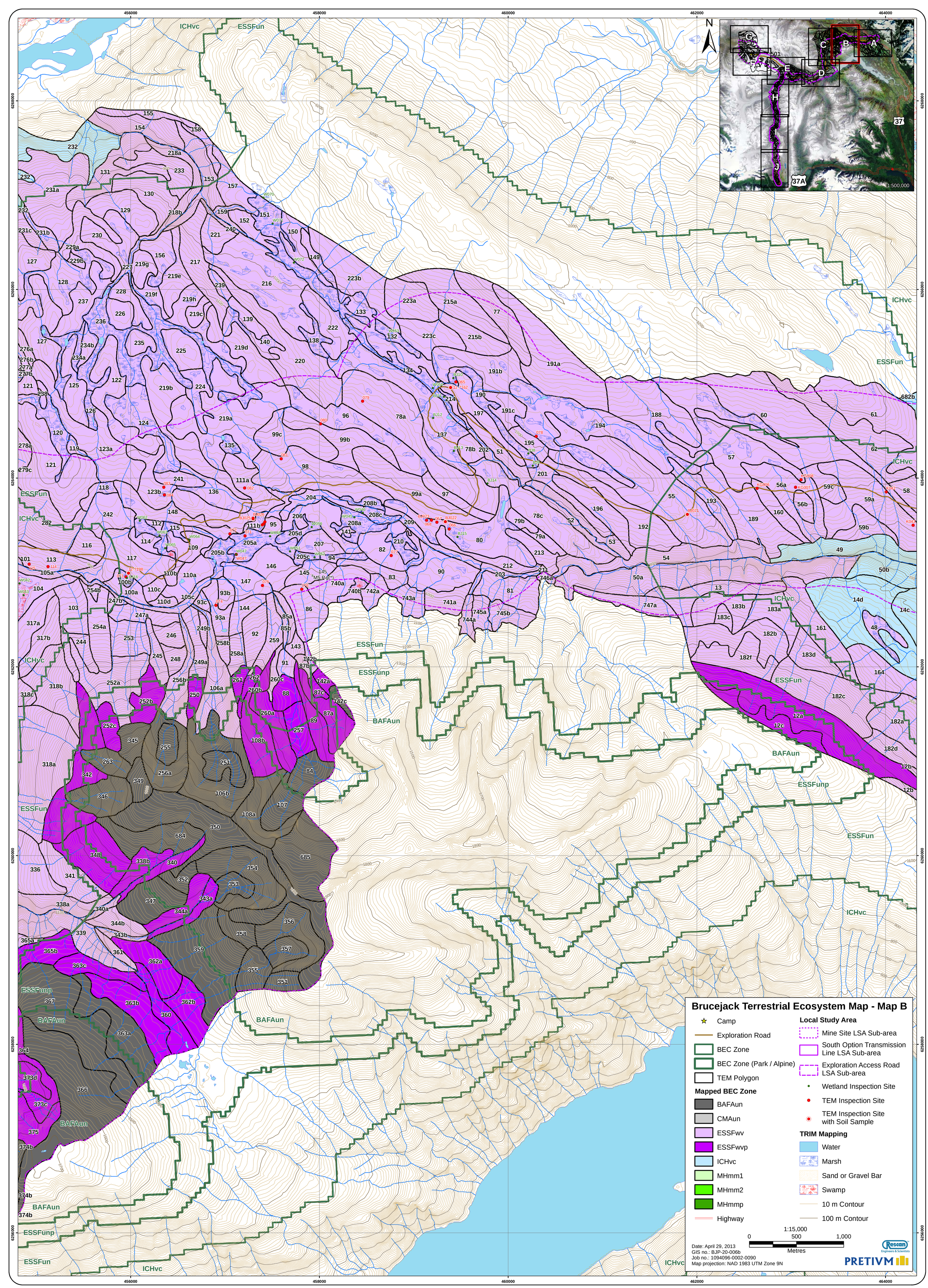
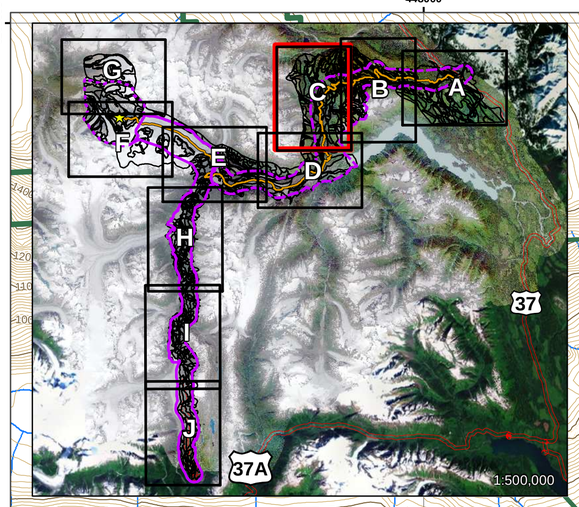


Brucejack Terrestrial Ecosystem Map - Map A
Camp
Exploration Road
BEC Zone
BEC Zone (Park / Alpine)
Terrain Polygon
Mapped BEC Zone
BAFAun
CMAun
ESSFwv
ESSFwvp
ICHvc
MHmm1
MHmm2
MHmmp
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-20-006a
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
PRETIVM
Bell-Irving River
Bowser Lake
ICHvc
ESSFun
ESSFunp
BAFAun
MHmm2


456000
458000
460000
462000
464000
6266000
6264000
6262000
6260000
6258000
6256000
N
ICHvc
ESSFun
ESSFunp
BAFAun
A
B
C
D
E
F
G
H
I
J
501
37
37A
1:500,000
Brucejack Terrestrial Ecosystem Map - Map B
Camp
Exploration Road
BEC Zone
BEC Zone (Park / Alpine)
TEM Polygon
Mapped BEC Zone
BAFAun
CMAun
ESSFwv
ESSFwvp
ICHvc
MHmm1
MHmm2
MHmmp
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-20-006b
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
Rescan
Engineers & Scientists
PRETIVM

Brucejack Terrestrial Ecosystem Map - Map C



- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- TEM Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-20-006c
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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Brucejack Terrestrial Ecosystem Map - Map D

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- TEM Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-20-006d
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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N

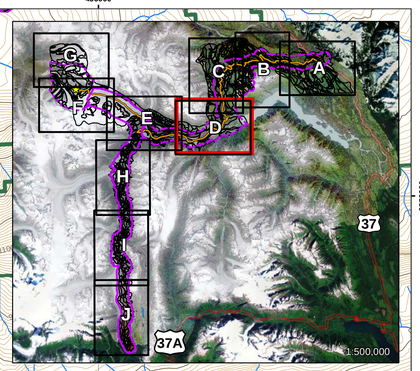
446000 448000 450000 452000 454000 456000

6252000 6254000 6250000 6248000

BAFAun ESSFunp ESSFun ICHvc CMAun MHmm2 MHmmp

Bowser Lake

Bowser River



Brucejack Terrestrial Ecosystem Map - Map E

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- TEM Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp

Local Study Area

- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-20-006e
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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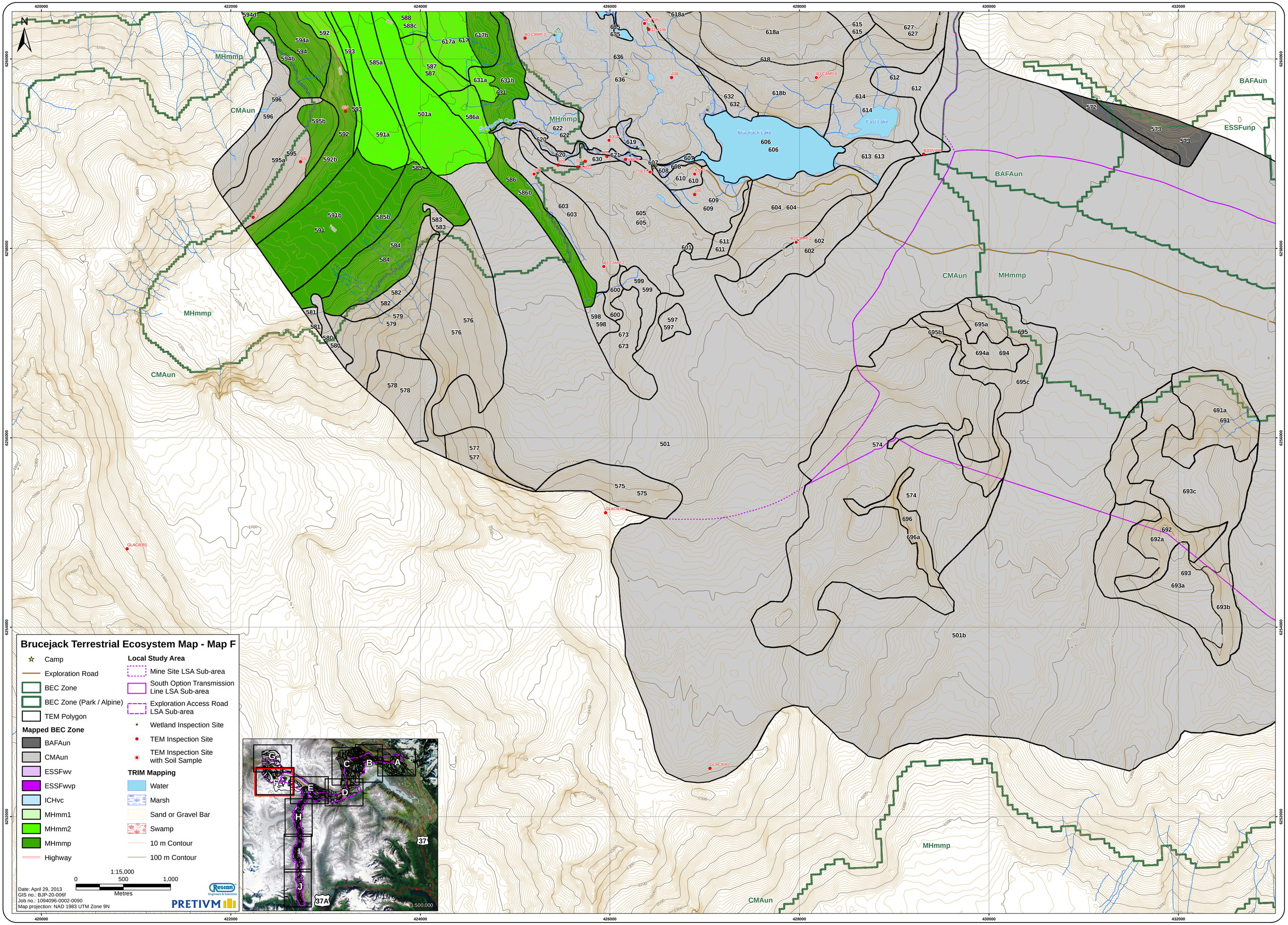

Brucejack Terrestrial Ecosystem Map - Map F
Camp
Exploration Road
BEC Zone
BEC Zone (Park / Alpine)
TEM Polygon
Mapped BEC Zone
BAFAun
CMAun
ESSFwv
ESSFwvp
ICHvc
MHmm1
MHmm2
MHmmp
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour
100 m Contour
1:15,000
0
500
1,000
Metres
Date: April 29, 2013
GIS no.: BJP-20-006f
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N
Rescan
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PRETIVM
Brucejack Lake
East Lake
MHmmp
CMAun
BAFAun
ESSFunp
GLACIER1
GLACIER2
1:500,000

Brucejack Terrestrial Ecosystem Map - Map G

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- TEM Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000

0 500 1,000

Metres

Date: April 29, 2013
GIS no.: BJP-20-006g
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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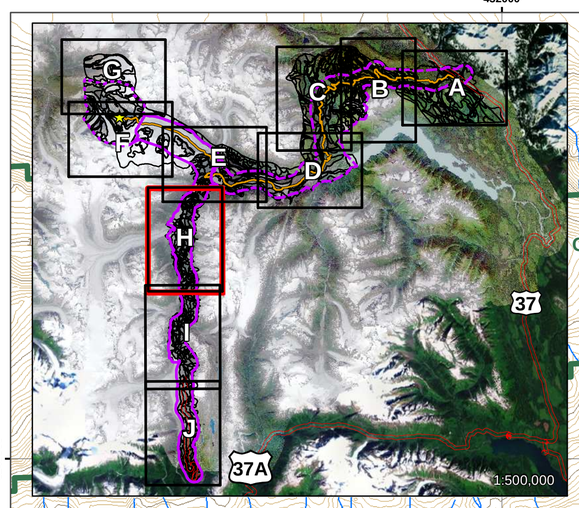

Brucejack Terrestrial Ecosystem Map - Map H

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- Terrain Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000
0 500 1,000
Metres

Date: April 29, 2013
GIS no.: BJP-20-006h
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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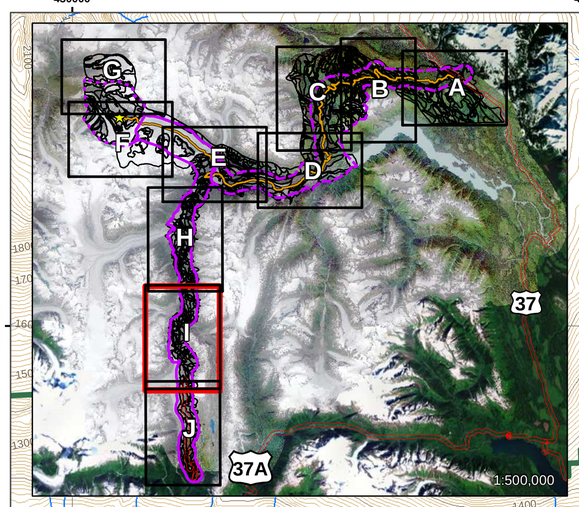
Brucejack Terrestrial Ecosystem Map - Map I



- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- TEM Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000
0 500 1,000
Metres

Date: April 29, 2013
GIS no.: BJP-20-006i
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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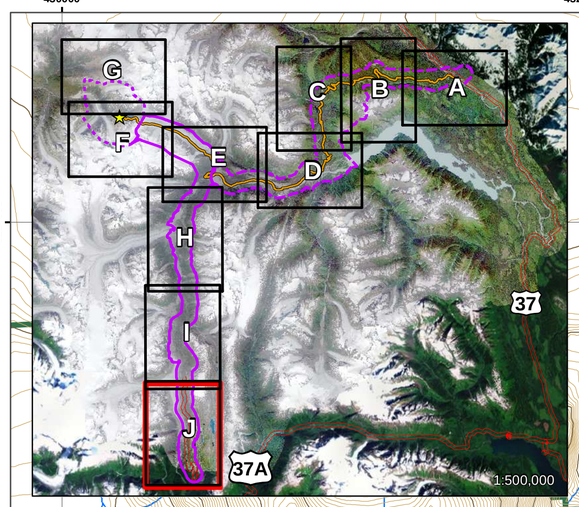
PRETIVM



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Brucejack Terrestrial Ecosystem Map - Map J

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- TEM Polygon

Mapped BEC Zone

- BAFAun
- CMAun
- ESSFwv
- ESSFwvp
- ICHvc
- MHmm1
- MHmm2
- MHmmp
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour
- 100 m Contour

1:15,000
0 500 1,000
Metres

Date: April 29, 2013
GIS no.: BJP-20-006j
Job no.: 1094096-0002-0090
Map projection: NAD 1983 UTM Zone 9N

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Appendix 7
Soil Mapping Units Maps

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Brucejack Soil Map - Map B

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- Soil Polygon Boundary
- Highway

Local Study Area

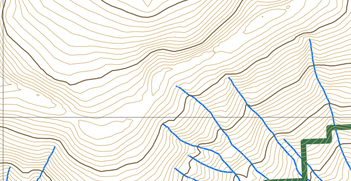
- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour Interval
- 100 m Contour Interval

Soil Map Polygon Label[1]



[1]where primary decile is less than 10, additional soil label data is provided in the appendicies.

Surficial Material

A	Anthropogenic - areas disturbed by human activity.
C	Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture
D	Weathered Bedrock - In-situ decomposed bedrock resulting in shallow, skeletal to fragmental soils and an irregular depth to consolidated bedrock and frequent occurrence of bedrock outcrops.
F	Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks and possibly glacial-fluvial processes
F '	Fluvial (active) - recent deposits of the active river/creek floodplain, associated with frequent flooding of the main channel; commonly sandy, very gravelly, often stratified deposits with little or no soil profile development (fragmental and skeletal soils).
G	Glaciofluvial - ice contact fluvial material locally very gravelly, often located in stratified, terraces above recent, active floodplains. Locally glaciofluvial deposits Includes recent and older materials.
I	Ice - Snowfields, icefields, glaciers
L	Lacustrine - lake sediments including some locally active ice contact (LG) lacustrine material near Knipple Lake
M	Morainal - high to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface
O	Organic - very dark, moderately decomposed organic material, often less than 1 m thick
R	Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10 cm thick) of unconsolidated or organic materials. Slightly deeper weathered may be included in these units
U	Undifferentiated - undifferentiated layered (3 or more) surficial materials commonly exposed along actively eroding channels or gullies
w	Open Water - Lakes, rivers, ponds

Soil Classification (Order)

B - Brunisol
G - Gleysol
P - Podzol
R - Regosol
O - Organic (Mesisols and Humisols)
n - Non-Soil

Soil Qualifier

g - Gleyed subgroups
p - peaty subgroups (organic layers 15 to 40 cm thick)
so - sombric A horizon (Ah at least 10 cm thick, often strongly acidic)

Soil Moisture Regime

0 - Very xeric
1 - Xeric
2 - Subxeric
3 - Submesic
4 - Mesic
5 - Subhygric
6 - Hygric
7 - Subhydric

1:15,000
0 500 1,000
Metres

Date: May 16, 2013
GIS #: BJP-17-004b
Project #.: 0194151-0003
Map projection: NAD 1983 UTM Zone 9N

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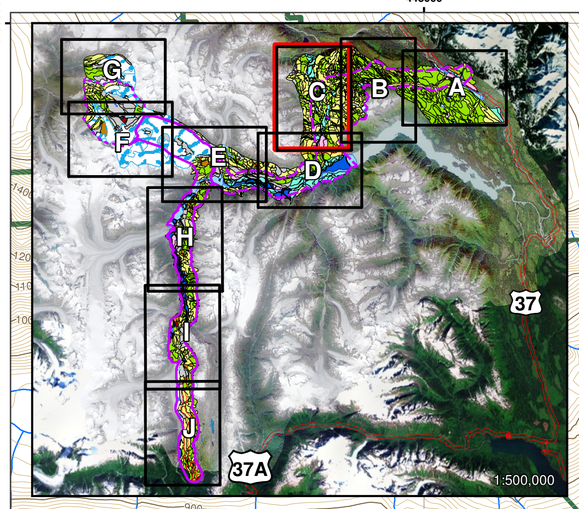
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Brucejack Soil Map - Map C

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- Soil Polygon Boundary
- Highway

Local Study Area

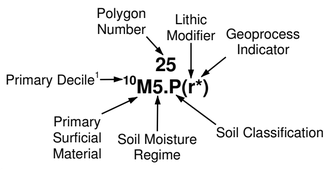
- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour Interval
- 100 m Contour Interval

Soil Map Polygon Label[1]



[1]where primary decile is less than 10, additional soil label data is provided in the appendicies.

Surficial Material

- A — Anthropogenic - areas disturbed by human activity.
- C — Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture
- D — Weathered Bedrock - In-situ decomposed bedrock resulting in shallow, skeletal to fragmental soils and an irregular depth to consolidated bedrock and frequent occurrence of bedrock outcrops.
- F — Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks and possibly glacial-fluvial processes
- F ' — Fluvial (active) - recent deposits of the active river/creek floodplain, associated with frequent flooding of the main channel; commonly sandy, very gravelly, often stratified deposits with little or no soil profile development (fragmental and skeletal soils).
- G — Glaciofluvial - ice contact fluvial material locally very gravelly, often located in stratified, terraces above recent, active floodplains. Locally glaciofluvial deposits Includes recent and older materials.
- I — Ice - Snowfields, icefields, glaciers
- L — Lacustrine - lake sediments including some locally active ice contact (LG) lacustrine material near Knipple Lake
- M — Morainal - high to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface
- O — Organic - very dark, moderately decomposed organic material, often less than 1 m thick
- R — Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10 cm thick) of unconsolidated or organic materials. Slightly deeper weathered may be included in these units
- U — Undifferentiated - undifferentiated layered (3 or more) surficial materials commonly exposed along actively eroding channels or gullies
- w — Open Water - Lakes, rivers, ponds

Soil Classification (Order)

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G - Gleysol
P - Podzol
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O - Organic (Mesisols and Humisols)
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Soil Qualifier

g - Gleyed subgroups
p - peaty subgroups (organic layers 15 to 40 cm thick)
so - sombric A horizon (Ah at least 10 cm thick, often strongly acidic)

Soil Moisture Regime

0 - Very xeric
1 - Xeric
2 - Subxeric
3 - Submesic
4 - Mesic
5 - Subhygric
6 - Hygric
7 - Subhydric

1:15,000
0 500 1,000
Metres

Date: May 16, 2013
GIS #: BJP-17-004c
Project #.: 0194151-0003
Map projection: NAD 1983 UTM Zone 9N

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Brucejack Soil Map - Map D

- Camp
- Exploration Road
- Terrain Polygon
- BEC Zone
- BEC Zone (Park / Alpine)
- Highway

Local Study Area

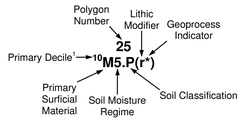
- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area

- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour Interval
- 100 m Contour Interval

Soil Map Polygon Label[1]



[1]where primary decile is less than 10, additional soil label data is provided in the appendicies.

Soil Classification (Order)

- B - Brunisol
- G - Gleysol
- P - Podzol
- R - Regosol
- O - Organic (Mesisols and Humisols)
- n - Non-Soil

Soil Moisture Regime

- 0 - Very xeric
- 1 - Xeric
- 2 - Subxeric
- 3 - Submesic
- 4 - Mesic
- 5 - Subhygric
- 6 - Hygric
- 7 - Subhydric

Soil Qualifier

- g - Gleyed subgroups
- p - peaty subgroups (organic layers 15 to 40 cm thick)
- so - sombric A horizon (Ah at least 10 cm thick, often strongly acidic)

Surficial Material

- A - Anthropogenic - areas disturbed by human activity.
- C - Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture
- D - Weathered Bedrock - In-situ decomposed bedrock resulting in shallow, skeletal to fragmental soils and an irregular depth to consolidated bedrock and frequent occurrence of bedrock outcrops.
- F - Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks and possibly glacial-fluvial processes
- F ' - Fluvial (active) - recent deposits of the active river/creek floodplain, associated with frequent flooding of the main channel; commonly sandy, very gravelly, often stratified deposits with little or no soil profile development (fragmental and skeletal soils).
- G - Glaciofluvial - ice contact fluvial material locally very gravelly, often located in stratified, terraces above recent, active floodplains. Locally glaciofluvial deposits Includes recent and older materials.
- I - Ice - Snowfields, icefields, glaciers
- L - Lacustrine - lake sediments including some locally active ice contact (LG) lacustrine material near Knipple Lake
- M - Morainal - high to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface
- O - Organic - very dark, moderately decomposed organic material, often less than 1 m thick
- R - Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10 cm thick) of unconsolidated or organic materials. Slightly deeper weathered may be included in these units
- U - Undifferentiated - undifferentiated layered (3 or more) surficial materials commonly exposed along actively eroding channels or gullies
- w - Open Water - Lakes, rivers, ponds

1:15,000
0 500 1,000
Metres

Date: May 16, 2013
GIS #: BJP-17-004d
Project #.: 0194151-0003
Map projection: NAD 1983 UTM Zone 9N

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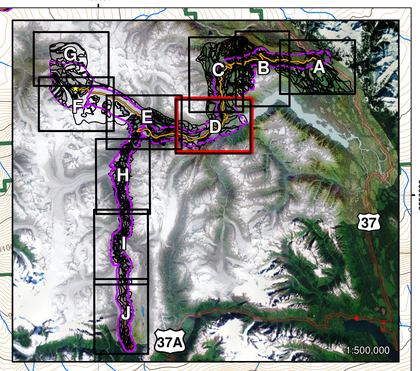

Bowser Lake
Bowser River

Brucejack Soil Map - Map E

- Camp
- Exploration Road
- BEC Zone
- BEC Zone (Park / Alpine)
- Soil Polygon Boundary
- Highway

Local Study Area

- Mine Site LSA Sub-area
- South Option Transmission Line LSA Sub-area
- Exploration Access Road LSA Sub-area
- Wetland Inspection Site
- TEM Inspection Site
- TEM Inspection Site with Soil Sample

TRIM Mapping

- Water
- Marsh
- Sand or Gravel Bar
- Swamp
- 10 m Contour Interval
- 100 m Contour Interval

Surficial Material

C	Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture
D	Weathered Bedrock - In-situ decomposed bedrock resulting in shallow, skeletal to fragmental soils and an irregular depth to consolidated bedrock and frequent occurrence of bedrock outcrops.
F	Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks and possibly glacial-fluvial processes
F '	Fluvial (active) - recent deposits of the active river/creek floodplain, associated with frequent flooding of the main channel; commonly sandy, very gravelly, often stratified deposits with little or no soil profile development (fragmental and skeletal soils).
G	Glaciofluvial - ice contact fluvial material locally very gravelly, often located in stratified, terraces above recent, active floodplains. Locally glaciofluvial deposits Includes recent and older materials.
I	Ice - Snowfields, icefields, glaciers
M	Morainal - high to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface
O	Organic - very dark, moderately decomposed organic material, often less than 1 m thick
R	Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10 cm thick) of unconsolidated or organic materials. Slightly deeper weathered may be included in these units
w	Open Water - Lakes, rivers, ponds

1:15,000

0 500 1,000

Metres

Date: May 16, 2013
GIS #: BJP-17-004e
Project #.: 0194151-0003
Map projection: NAD 1983 UTM Zone 9N

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Soil Map Polygon Label[1]

Polygon Number — Lithic Modifier — Geoprocess Indicator

Primary Decile[1] → 10 25 M5.P(r*)

Primary Surficial Material — Soil Moisture Regime — Soil Classification

[1]where primary decile is less than 10, additional soil label data is provided in the appendicies.

Soil Classification (Order)

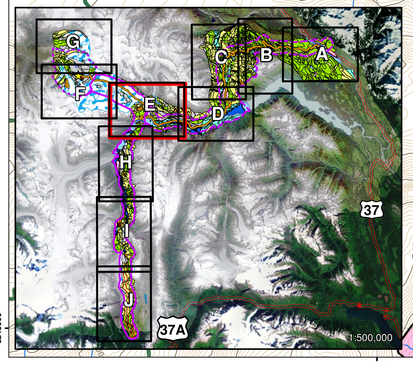
- B - Brunisol
- G - Gleysol
- P - Podzol
- R - Regosol
- O - Organic (Mesisols and Humisols)
- n - Non-Soil

Soil Moisture Regime

- 0 - Very xeric
- 1 - Xeric
- 2 - Subxeric
- 3 - Submesic
- 4 - Mesic
- 5 - Subhygric
- 6 - Hygric
- 7 - Subhydric

Soil Qualifier

- g - Gleyed subgroups
- p - peaty subgroups (organic layers 15 to 40 cm thick)
- so - sombric A horizon (Ah at least 10 cm thick, often strongly acidic)



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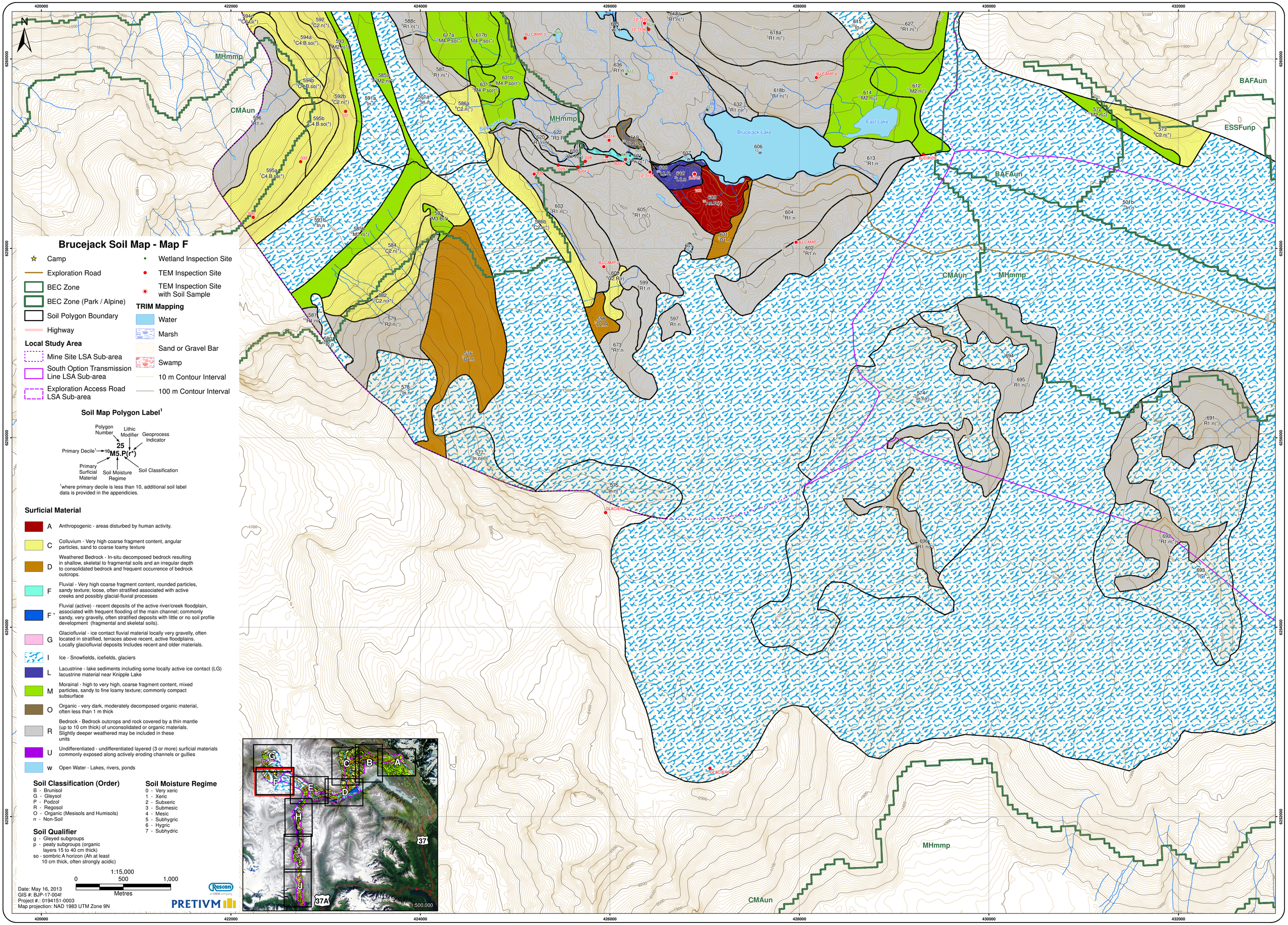

Brucejack Soil Map - Map F
Camp
Exploration Road
BEC Zone
BEC Zone (Park / Alpine)
Soil Polygon Boundary
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
Wetland Inspection Site
TEM Inspection Site
TEM Inspection Site with Soil Sample
TRIM Mapping
Water
Marsh
Sand or Gravel Bar
Swamp
10 m Contour Interval
100 m Contour Interval
Soil Map Polygon Label[1]
Polygon Number
Lithic Modifier
Geoprocess Indicator
Primary Decile[1]
25
M5.P(r*)
Primary Surficial Material
Soil Moisture Regime
Soil Classification
[1]where primary decile is less than 10, additional soil label data is provided in the appendicies.
Surficial Material
A Anthropogenic - areas disturbed by human activity.
C Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture
D Weathered Bedrock - In-situ decomposed bedrock resulting in shallow, skeletal to fragmental soils and an irregular depth to consolidated bedrock and frequent occurrence of bedrock outcrops.
F Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks and possibly glacial-fluvial processes
F' Fluvial (active) - recent deposits of the active river/creek floodplain, associated with frequent flooding of the main channel; commonly sandy, very gravelly, often stratified deposits with little or no soil profile development (fragmental and skeletal soils).
G Glaciofluvial - ice contact fluvial material locally very gravelly, often located in stratified, terraces above recent, active floodplains. Locally glaciofluvial deposits Includes recent and older materials.
I Ice - Snowfields, icefields, glaciers
L Lacustrine - lake sediments including some locally active ice contact (LG) lacustrine material near Knipple Lake
M Morainal - high to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface
O Organic - very dark, moderately decomposed organic material, often less than 1 m thick
R Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10 cm thick) of unconsolidated or organic materials. Slightly deeper weathered may be included in these units
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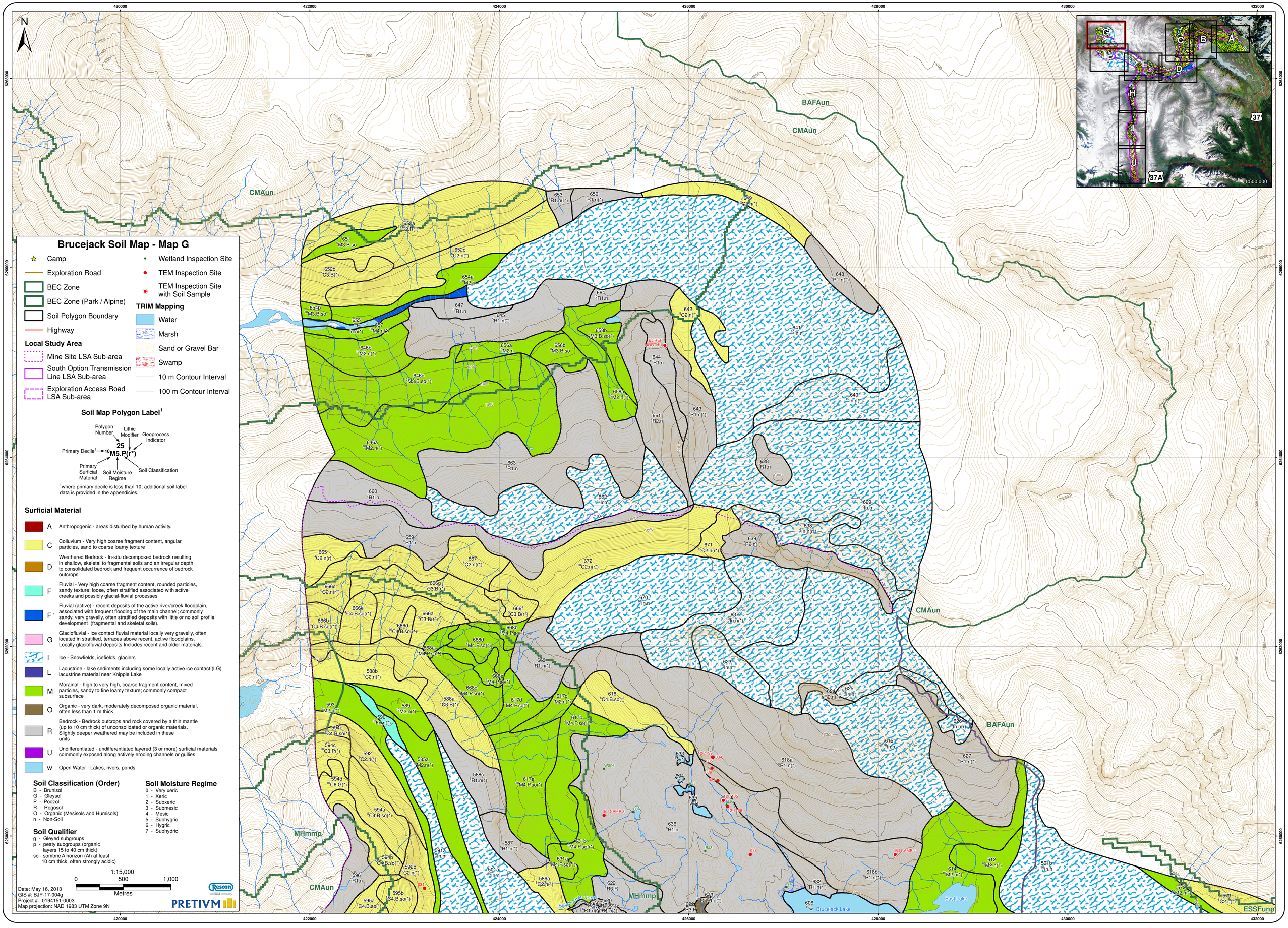

Brucejack Soil Map - Map G
Camp
Exploration Road
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Soil Polygon Boundary
Highway
Local Study Area
Mine Site LSA Sub-area
South Option Transmission Line LSA Sub-area
Exploration Access Road LSA Sub-area
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Polygon Number
Lithic Modifier
Geoprocess Indicator
Primary Decile[1]
25
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Brucejack Lake
East Lake
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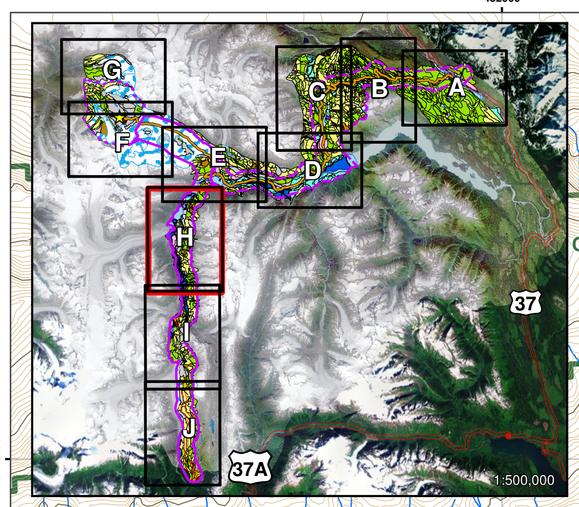
Brucejack Soil Map - Map H



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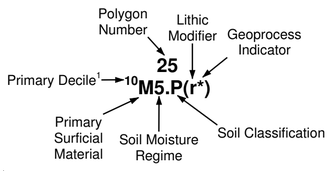

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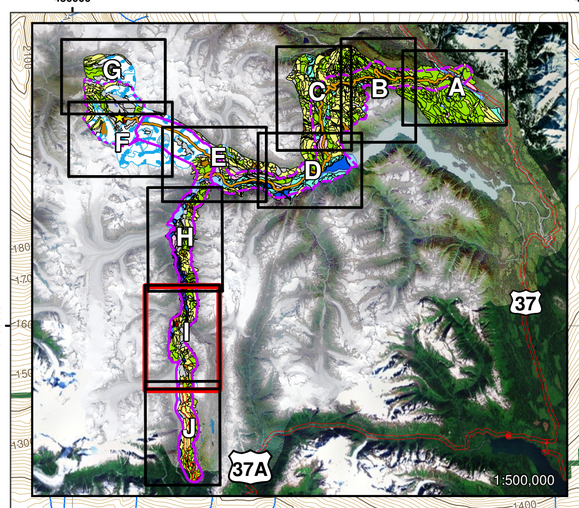
Brucejack Soil Map - Map I



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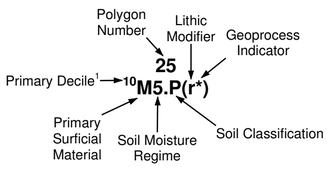

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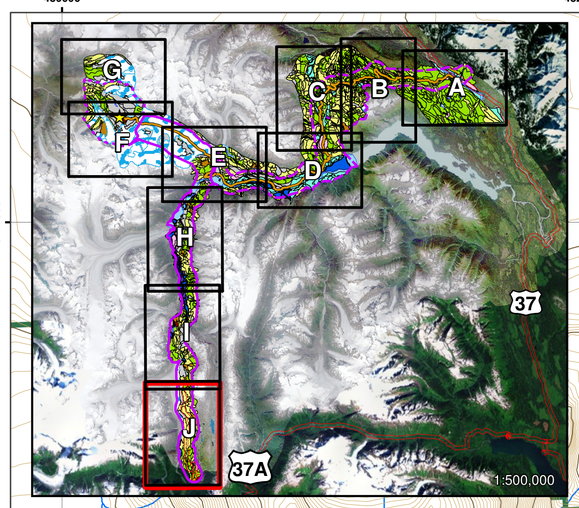

Brucejack Soil Map - Map J

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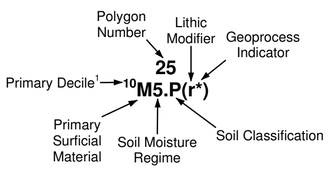

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GIS #: BJP-17-004j
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Appendix 8

2012-2013 Rare Plant and Lichen Report

Rescan™
Engineers and Scientists

Pretium Resources Inc.

BRUCEJACK GOLD MINE PROJECT
2012-2013 Rare Plant and Lichen Report

PRETIVM

Rescan™ Environmental Services Ltd.
Rescan Building, Sixth Floor - 1111 West Hastings Street
Vancouver, BC Canada V6E 2J3
Tel: (604) 689-9460 Fax: (604) 687-4277

December 2013

BRUCEJACK GOLD MINE PROJECT

2012-2013 RARE PLANT AND LICHEN REPORT

December 2013
Project #0194150-0003-0098

Citation:
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Prepared for:

PRETIVM

Pretium Resources Inc.

Prepared by:

Rescan™ Engineers and Scientists

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary

Rescan™
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Executive Summary

The Brucejack Gold Mine Project (the Project) is a proposed underground gold mine located within the Kitimat-Stikine Regional District of northwest British Columbia, approximately 65 km north-northwest of Stewart, and 21 km south-southeast of the Eskay Creek Mine.

As part of the baseline studies and to support and Environmental Assessment Certificate application, rare plant studies were in 2012 and 2013 to determine the presence of species that have a conservation-priority S-ranking (subnational (i.e., provincial) conservation ranking; protection under the Species at Risk Act (SARA), those ranked as threatened or endangered by COSEWIC or otherwise considered rare within the LSA and at select sites within the surrounding area.

Surveys were timed to optimize plant identification (e.g., during flowering and/or fruiting) and occurred twice during the summer of 2012 (July 12 to 17, and August 31 to September 3). All surveys were conducted by a qualified botanist using a controlled intuitive wander method. Survey efforts focused on sites where proposed infrastructure overlapped with likely rare plant habitat within the LSA. Outside of the LSA, rare plant surveys were conducted at select sites to provide a regional context of plant and lichen species.

The results of this study provide important information on plant and lichen biodiversity in the northern Coast Ranges, including the discovery and documentation of species new to science, geographical range extensions and species habitat specificity. A total of 2,873 plants and lichens were identified. Most of the species identified were vascular plants, followed by macrolichens (micro- and macrolichens are the largest group if combined), mosses and liverworts. This is the opposite of the global trend, wherein lichens are typically less diverse than vascular plants within the average landscape. The total species richness identified during surveys or through specimen identification is 953 species. Site lists ranged from 54 to 326 species, with an average per-site species richness of 155.

Seventy-six rare plant and lichen species were identified within the LSA, consisting of 19 vascular plant, 42 lichen and 15 moss species. None of the rare species found are currently listed under the SARA or by COSEWIC; however one species is on the candidate list for the SARA. Fifty nine of the species are listed by the BC CDC and 17 are considered rare but previously undocumented in British Columbia, new to science or ranked as SU (i.e., uncertain by the BC CDC).

This information and data will provide the basis for evaluating potential effects on rare plants and lichens related to the Project as required by the *Environmental Assessment Act* (1980) and will be used to guide Project planning and management.

Acknowledgements

Rescan™
Engineers and Scientists

Acknowledgements

This report was produced for Pretium Resources Inc. by Rescan Environmental Services Ltd. It was written by Curtis Björk (MSc.), and reviewed by Natasha Bush (B.Sc., P.Ag.) and Daniel McAllister (M.Sc., P.Ag.). The project was managed by Andrew Duthie (M.Sc.) and Greg Norton (M.Sc.). Graphics production was coordinated by Francine Alford (B.F.A.), GIS production was coordinated by Pieter van Leuzen (M.Sc.) and report production was coordinated by Robert Tarbuck (BTECH). Field work was conducted in 2012 by Curtis Björk and Ryan Batten with assistance from Brian Tait and Danny Wilson.

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Engineers and Scientists

BRUCEJACK GOLD MINE PROJECT
2012-2013 RARE PLANT AND LICHEN REPORT

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Glossary and Abbreviations

Rescan™
Engineers and Scientists

Glossary and Abbreviations

Algae	Photosynthetic organisms of a variety of evolutionary groups. Only the so-called green algae (the evolutionary ancestors of plants) are of concern in the rare plant surveys. Green algae may be green, red, orange or brown in colour; the term "green algae" reflects their usual colour and reflects the photosynthetically active compounds they contain.
Apothecia (singular apothecium)	A spore-bearing structure of lichens.
Calcareous	Refers to calcium and associated high-pH minerals. Calcareous rocks and soils are rich in mineral nutrients essential to the growth of many plants.
Calciphilic	Said of plants and lichens that require high concentrations of calcareous minerals in the soil, rock or water they grow in
BC CDC	British Columbia Conservation Data Centre (which see).
British Columbia Conservation Data Centre	The British Colubmia provincial governmental office having the responsibility of maintaining lists of conservation-priority species, as well as data on occurrences of those rare species. Conservation Data Centres are tied through data uploads to the Natureserve system offices in Virginia.
Brucejack Gold Mine Project	The Project
Cf.	From Latin *confer*, or "to compare against". Used with plant and lichen Latin names in cases where a specimen in hand is a poor match for the species to which the cited name applies, while there is no better name to apply. Species cited in this way may be new to science, but insufficient information or specimens are available to determine this definitively.
Conservation	Avoidance of damage or disturbance to biodiversity and wild landscapes or habitats.
Controlled intuitive wander	The standard method for rare plant surveys, in which the surveyor is free to "wander", focusing on habitats and landscape features that yield the highest numbers of species and which have the greatest likelihood of harbouring rare species.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada. A committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada.
Cyanobacteria	A group of evolutionarily related bacteria that, like plants, is photosynthetic. Cyanobacteria are important ecologically as one of the only organisms with the ability to convert nitrogen from its N_2 elemental form (which is biologically useless) to a "fixed" compound form (nitrates, nitrites or ammonia) that is useful to plants as an essential nutrient for growth.
Demographics	The study of populations of organisms, focusing on changes in numbers of individuals, mortality, juvenile recruitment and other dynamics of population size.

Element occurrence	a population of a conservation-priority plant, or other organism, or plant habitat. Term used by the BC Conservation Data Centre.
Epiphytic	Said of a plant or lichen that grows on the surface of a tree or shrub, or on the coarse woody debris of trees and shrubs.
G-rank	A conservation rank of 1 (rare) through 5 (common and secure) assigned to species based on range, abundance and any threats across its entire global range.
Genus	A grouping of similar and evolutionarily related species. Example: *Tsuga* (hemlock) is the genus that includes the entire suite of hemlock tree species, of which British Columbia has two: *Tsuga heterophylla* (Pacific hemlock), and *Tsuga mertensiana* (mountain hemlock).
Gossen (also spelled gossan)	A siliceous rock type containing strong iron concentrations, giving it a characteristic rusty colour.
Guano	Fecal deposits from certain animals, particularly birds. Guano is particularly nutrient-rich (in nitrogen and often phosphorus, calcium, magnesium and potassium) and so is important for many plant and lichen species in arctic tundra, a landscape lacking in many of the nutrients provided in guano.
Herbarium	A natural history depository for plants, lichens, fungi and algae. Herbaria are important for documentation of the results of rare plant surveys.
Ined.	From Latin "ineditus" *unpublished*. Used when a name has been chosen for a species new to science, but that name and the species it represents remain unpublished.
Intuitive wander	See "controlled intuitive wander."
Lichen	Organisms formed from the close symbiotic association of a lichen-specialist fungus and photosynthetic algae and/or cyanobacteria.
Lichenized	Said of organisms that are involved in lichen symbioses. When lichenized, organisms change greatly in appearance, biochemistry or other characteristics than in an unlichenized state, and most species capable of lichenization are incapable of living in an unlichenized state.
Liverwort	A group of evolutionarily related plants that lack seeds, flowers, pollen and vasculature (water-moving tubes). They are similar to mosses in these regards, but differ in many ways, including in having relatively delicate tissues, and in their reproductive structures and general appearance.
Macrolichens	A group of evolutionarily unrelated lichens that are treated together for convenience as being those lichens that are sufficiently large to be identified with a hand-lens, and which usually can be collected without gathering also a piece of the substrate they grow on. Macrolichens generally grow three-dimensionally, lifting from the substrate. For contrast, see also "microlichen."
Metalliferous	Metal bearing, said of certain rock types having unusually strong concentrations of iron, lead, zinc or other metals. See also "gossen."

Microhabitat Habitats of small spatial scale. Microhabitats are generally more relevant to rare plant and lichen species than are macrohabitats. Macrohabitats are those that blanket a landscape and so are easily observed at a glance across the landscape. Microhabitats generally have to be observed up close and are scarce in the landscape.

Microlichens A group of unrelated lichens that are treated together in contrast to the macrolichens. Microlichens are those that usually must be observed at a microscopic scale to identify. They also have the attribute of growing so intimately attached to the substrate they grow on as to require the collection of the substrate along with the lichen. Microlichens are generally two-dimensional, growing as encrustations over the substrate.

Mineral nutrient A metallic or ionic nutrient essential for plant growth. Examples are calcium, magnesium, potassium or phosphorus.

Monitoring A conservation method that involves repeated observations of populations and habitats to detect any changes in population size or area. Monitoring is usually done in the context of natural resource development or environmental cleanup.

Moss A group of environmentally related organisms that lack seeds, flowers, pollen and vasculature (water-moving tubes). They are similar to liverworts in these regards, but differ in many ways, including having relatively tough tissues, longer-lasting spore capsules on relatively tough stalks, and in general appearance.

Native Said of plants that occur in the area where they evolved or where they colonized without the aid of humans. Non-native species are those accidentally or intentionally introduced by human activity.

Nitrogen An element that in its "fixed" form is an essential nutrient for life, but which in its elemental (N_2) form is not useful to most life forms (except a few specialized bacteria). See also "cyanobacteria".

pH A measure of the acidity/alkalinity scale. Soil, water and rock pH is important in plant and lichen ecology; a disproportionate number of rare lichens and plants are dependent on high-pH habitats. Biologically significant "alkaline" is around pH 5.5 and higher.

Phenology The annual timing of plant development stages (leafing out, flowering, fruiting, senescence, dormancy, etc.).

Photosynthetic Said of organisms that are capable of photosynthesis, which is the use of light energy to convert carbon dioxide into sugars and starches. Photosynthesis is essentially the "storage" of light energy in chemical form for later consumption.

Plant A group of evolutionarily related organisms that include mosses, liverworts, vascular plants, hornworts (no hornworts are known to occur in the Arctic), and perhaps also the green algae.

Population A group of organisms of the same species that occur in such close proximity that they have the potential to mate with each other.

Population area The geographical area covered by a population.

Population size The number of individuals in a population.

Relief	Elevational variation in a landscape. See also "topography."
SARA (Species at Risk Act)	A Canadian federal law that governs the management of legally designated species and their habitats in certain circumstances.
Seepage	A minor, slow flow of water over a rock or soil surface, often depositing minerals as it flows and evaporates. Seepage slopes are often important habitat for rare plants and lichens.
Siliceous	From "silicon," to refer to rocks having a silicate matrix, such as granite, gneiss or quartzite. Siliceous rocks and their derived soils are generally of low pH and poor in mineral nutrients.
Sp. nov.	From Latin *Species nova*, or "new species." Used with a Latin name for organisms that are new to science. They may be used for unpublished species, or upon the first official publishing of a new species.
Sp.	Species (singular).
Spp.	Species (plural).
Species	A group of evolutionarily related organisms of similar characteristics that is identifiable in contrast to all other species.
Subnational	Refers to territories, provinces and states in relation to conservation ranking, in contrast to national or global conservation ranks.
Symbiotic	Said of intimately close biological relationships between unrelated organisms. Lichens, for example, are a symbiosis of a fungus and a photosynthetic organism.
Taxonomy	The study of taxa. Taxa are groupings of similar and evolutionarily related organisms, i.e., species, genera, families, subspecies, varieties. Taxonomy has as its goal the optimal definition and naming of each taxon based on its observable characteristics and evolutionary history.
Thallus	A lichen "body," referring specifically to the non-reproductive portions.
Topography	Elevational and structural variation in a landscape, including hills, canyons, mountains and other features.
Tracked	Said of species, subspecies and varieties that are considered conservation priorities. Populations of these species are 'tracked' in order to better understand population changes due to natural or human-caused effects.
UBC	The University of British Columbia Herbarium. See also "Herbarium."
Vascular plant	A group of evolutionarily related plants exclusive of mosses, liverworts and hornworts. Vascular plants are characterized by having vasculature (internal tubing that is capable of water and mineral transport up through the plant), and generally larger size and greater elaboration of stem and leaf forms. The vascular plant grouping includes ferns, conifers, flowering plants and several other groups.

1. Introduction

1. Introduction

1.1 OVERVIEW

Pretium Resources Inc. is proposing to develop the Brucejack Gold Mine Project (the Project). The Project is located within the Kitimat-Stikine Regional District of northwest British Columbia, approximately 65 km north-northwest of Stewart, and 21 km south-southeast of the Eskay Creek Mine (Figure 1.1-1).

As part of the baseline studies and in partial fulfillment of the Environmental Assessment Certificate application, rare plant studies were conducted in 2012 and 2013.This report presents the results of rare plant and lichen studies, including a summary of provincial and federal rare plants and lichens that may require consideration in the permit application.

Rare plant and lichen species may be of major importance to their habitats and to wildlife, as keystone species, for potential or known medicinal uses, as subjects of study that may help us to glean evolutionary relationships among organisms, or any of a wide array of other important attributes. As northern and alpine climates change rapidly, some currently rare species may be important to expand their ranges to fill niches left vacant by species that disappear with warming, drying or newly unstable climates. Plant and lichen conservation is key to protecting overall biodiversity in landscapes. Conserving a maximum number of plant and lichen species also helps to preserve the landscape visual quality of wild lands, as they are often attractive, adding to landscapes showy flowers, lush green mossy ground, or impressive arrays of lichen growth form and colour.

1.2 OBJECTIVES

Rare plant and lichen surveys were conducted to determine the presence of provincially or globally rare plant or lichen species within the Local Study Area (LSA) and at select sites within the surrounding area. The following sections summarize the methods and rationale used to conduct the rare plant and lichen surveys as well as the key findings from this study.

This information and data will provide the basis for evaluating potential effects on rare plants and lichens related to the Project as required by the *Environmental Assessment Act* (1980) and will be used to guide Project planning and management.

The objectives of the rare plant surveys were to:

- identify locations of rare plants and lichens within the LSA, particularly in areas that overlap with proposed infrastructure;
- identify the type and locations of likely rare plant habitats within the LSA;
- establish complete lists of species present in each site surveyed;
- establish a complete list of flora within the LSA; and
- refine understanding of the regional context of the identified rare plants, in terms of expected range, regional rarity, and habitat.

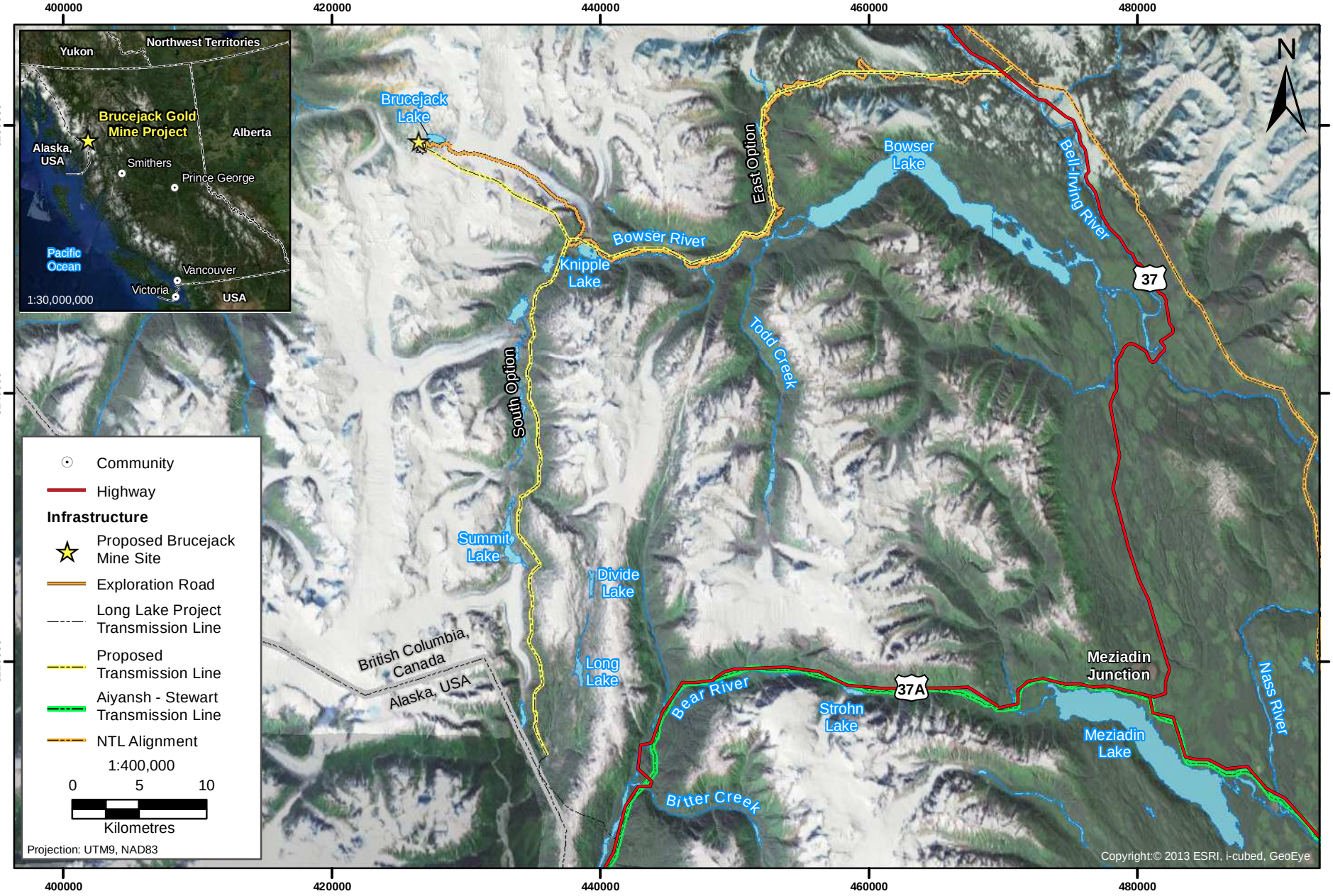

Figure 1.1-1

PRETIVM

Brucejack Gold Mine Project Overview

Figure 1.1-1

Rescan™ Engineers & Scientists

1.3 STUDY AREA

Rare plant surveys occurred within a Local Study Area (LSA) defined for the terrestrial ecosystem studies and at select sites within the surrounding area. The LSA is 31,847 ha in size and is defined by a minimum 1 km buffer extending at least to the height of land around the outer limits of the proposed infrastructure and linear developments. Surveys were concentrated in and immediately around proposed footprint areas, and currently used camps. Areas already altered by development were not included in the survey. Rare plant surveys focused predominantly on the following areas:

- fringes of Brucejack Lake;
- alpine ridges near the existing Brucejack Camp;
- the Bowser River Valley and adjacent alpine ridges; along the exploration access road;
- the vicinity of the Knipple Glacier;
- the headwater areas of Scott Creek;
- sites proposed for infrastructure around Wildfire Camp; and
- along the proposed Transmission Line-South Option.

2. Methods

2. Methods

Rare plant surveys are distinct from ecosystem mapping in goals and methods, with the intention of detecting all species present in a given area. While vegetation and ecosystem mapping focuses on dominant plant and lichen species in vegetation associations, rare plant surveys focus on species that are considered rare at the provincial (BC), national and global scales. This section outlines the methods used to determine target rare plant species and associated habitat as well as survey design and data collection. Also included is a summary of quality assurance and control measures that were included in the design of rare plant and lichen studies.

2.1 IDENTIFICATION OF TARGET SPECIES FOR RARE PLANT AND LICHEN SURVEYS

In preparation for Project rare plant surveys, a list of potential rare species and associated habitat was compiled. This list included those species that have a conservation-priority S-ranking (subnational [i.e., provincial] conservation ranking according to NatureServe; Table 2.1-1), protection under the *Species at Risk Act* (SARA 2002b) and those ranked as threatened or endangered by COSEWIC.

In addition to these target rare species, research was conducted to identify species previously unreported for the province and possibly of conservation concern. Based on the list of potential rare species, areas of greater likelihood for finding rare species (e.g., cliffs, alpine scree slopes, and ephemeral ponds) were selected for the rare plant surveys.

Table 2.1-1. NatureServe National and Subnational Conservation Status Ranks and Definitions

Rank Status	Definition
T	SARA- and COSEWIC-listed Threatened
S1	Extremely rare at the provincial level; 5 or fewer occurrences, or very few remaining individuals; critically imperiled and susceptible to extirpation due to a factor of its biology
S2	Rare at the provincial level; 6 to 20 occurrences, or few remaining individuals; imperiled, may be susceptible to extirpation due to some factor of its biology
S1S2[1]	Extremely rare to rare at the provincial level
S3	Vulnerable at the provincial level; 21 to 100 occurrences; may be rare and local throughout the province or may occur in a restricted provincial range (may be abundant in some places); may be susceptible to extirpation by large scale disturbances
S2S3[1]	Rare to vulnerable at the provincial level
S4	Common at the provincial level; more than 100 occurrences; generally widespread and abundant but may be rare in parts of its range; apparently secure
S3S4[1]	Vulnerable to common at the provincial level
S5	Very common and demonstrably secure at the provincial level; more than 100 occurrences; widespread and abundant, but may be rare in parts of its range
S4S5[1]	Common to very common at the provincial level
SNR	Not ranked; presence confirmed, but province-wide abundance, range and any threats not yet assessed
SNA	No rank status given, used for non-native species

[1]*A Range Rank (i.e., S2S3) is used when existing information on an element straddles the criteria defining two separate ranks.*

2.2 IDENTIFICATION OF TARGET HABITAT FOR RARE PLANTAND LICHEN SURVEYS

Selecting areas of focus for rare plant and lichen surveys is guided both by a need to cover a maximal area of proposed footprints and by the distribution of biodiversity in the study area. The most species-rich habitats and the best habitats for finding rare plants and lichens may or may not coincide with Project footprint areas.

Choice of habitats for survey focus can be guided by vegetation, soil and geology mapping. Survey sites were also selected based on occurrences of small-scale anomalies in soil or surface bedrock types, or hydrologic or topographic features. The surveys spanned the full elevation range of the survey area, covering a wide array of landscape topographic features, aspects and slopes. Final site selection was made during reconnaissance flights, and refined during on-the-ground surveys.

2.3 FIELD SURVEYS

2.3.1 Survey Design

Surveys were timed to optimize plant identification (e.g., during flowering and/or fruiting) and occurred twice during the summers of 2012 (July 12 to 17 and August 31 to September 3) and 2013 (July 9 to 16 and August 15 to 20).

Survey efforts focused on sites where proposed infrastructure overlapped with likely rare plant habitat within the LSA. Outside of LSA, rare plant surveys were conducted at select sites to provide a regional context of plant and lichen species. Furthermore, presence/not-detected level surveys for rare plants were conducted at general field survey sites within the LSA and RSA.

All surveys were conducted by a qualified botanist using a controlled intuitive wander method. Intuitive wander methods guide searches through the maximum number of habitats possible during a site survey. Lingering too long in a single habitat greatly reduces the number of species that can be found. By covering a maximum of habitats in a day's surveys, intuitive wanders also avoid oversampling from the dominant, widespread habitats that tend to have few rare species. The distance covered in each intuitive wander depends on the number of species recorded over spans of time and search effort. Habitats of low species diversity thereby receive less survey time than those having higher species diversity. Habitats with dense concentrations of species may become the focus of an entire day's survey so long as additional species are added to the list with significant frequency up to the end of the field day. In British Columbia, rare species tend to occur in sites having higher overall levels of species diversity, so finding a maximum number of species per site by focusing on species-rich habitats also generates a greater likelihood of finding rare species (C. Björk, pers. comm.).

At each site, all vascular plant, moss, liverwort and lichen species observed were recorded. When a species was unknown in the field, or required laboratory techniques to confirm, a specimen was collected for later study. Specimens were deposited at the University of British Columbia (UBC) Herbarium in Vancouver, BC (Canada) in January 2013.

All taxa encountered were identified to the level of species or lower. Some species encountered were given provisional names (as with *Peltigera conspersa* ined., or *Draba* sp. nov.*,* as it appears that they represent no published species, and are thus treated as putative species new to science. Uncertain identifications are indicated in the Project species list either by a question mark, or as "cf." (from the Latin for "compare against"), which represents uncertainty as to how the cited species should be defined, and whether the observed plant or lichen fits within that species' definition. Uncertainty in identification that is reported with a question mark may be the result of having only poorly formed

specimens that are difficult to interpret, or may arise from having observed too few individuals to be sure of their characteristics. Liverworts and microlichens were recorded only as incidental observations and complete lists of these groups were not attempted.

2.3.2 Data Collection

When a rare species population was encountered, representative coordinates were recorded by use of a Garmin GPS 60csx unit. The habitat characteristics of the population were recorded, and a general population size was estimated.

When possible, at least one example of each rare species encountered in the 2012-2013 rare plant and lichen surveys was documented with a voucher specimen. Voucher specimens were not taken from exceedingly small populations or from populations that were unlikely to recover from the loss of an individual. Additionally, when weather and lighting conditions allowed, a voucher photograph was taken for at least one population of each rare species.

2.3.3 Quality Assurance and Quality Control

Successful rare plant surveys rely first and foremost on accurate species identification. Hence it is important to collect large numbers of specimens at each survey site, and to document species with field photographs. Accurate identifications can be made only by use of a well-stocked taxonomic library. Floras do not cover all taxa encountered in any given project area, and the taxonomy they employ becomes outdated not long after the date of publication. The assurance for accuracy of identification hence relies on original taxonomic literature on genera and species.

Additional quality control is achieved by use of voucher documentation gathered during the field surveys. These are compared against characteristic specimens and photographs of species to ensure correct application of species names, and to detect any distinctions that may reveal species not previously known for a region or those potentially new to science. Comparisons are conducted in a herbarium (natural history museum for plants, lichens, fungi and algae). Herbarium collections at the UBC Herbarium (University of British Columbia, Vancouver) were used for comparison for the 2012 and 2013 rare plant and lichen surveys.

3. Results

3. Results

3.1 IDENTIFICATION OF TARGET SPECIES FOR RARE PLANT AND LICHEN SURVEYS

The species lists compiled for the LSA included vascular plants, macrolichens and mosses. Liverworts and microlichens were recorded only as incidental observations because there is very little information of the conservation ranking in BC for these species.

In total, 235 species were included in the potential rare species list (Tables 3.1-1 to 3.1-3), including 90 lichens, 62 mosses, and 83 vascular plants. The list at the outset of the field work included different species than those included at the last day of field surveys. This was due to findings that some species ranked as conservation priorities were found during the field surveys to be more common than previously thought, or in other cases due to the discovery of species not previously known from British Columbia and that are rare or rare species that are apparently undescribed and therefore new to science.

Table 3.1-1. Rare Plant Surveys: Target Lichens Species

Acroscyphus sphaerophoroides	*Dermatocarpon leptophyllodes*	*Pilophorus vegae*
Ahtiana sphaerosporella	*Dibaeis baeomyces*	*Placynthium asperellum*
Alectoria sarmentosa ssp. *vexillifera*	*Evernia divaricata*	*Placynthium tantaleum*
Allantoparmelia almquistii	*Evernia perfragilis*	*Psoroma tenue* var. *boreale*
Allocetraria madreporiformis	*Fuscopannaria ahlneri*	*Santessoniella arctophila*
Anaptychia crinalis	*Fuscopannaria confusa*	*Santessoniella saximontana*
Arctoparmelia incurva	*Fuscopannaria crustacea*	*Sclerophora peronella*
Arctoparmelia separata	*Fuscopannaria incisa*	*Solorina bispora*
Asahinea scholanderi	*Fuscopannaria leucostictoides*	*Solorina octospora*
Baeomyces carneus	*Fuscopannaria pacifica*	*Solorina spongiosa*
Baeomyces placophyllus	*Fuscopannaria ramulina*	*Sphaerophorus fragilis*
Bryoria nadvornikiana	*Hypogymnia canadensis*	*Spilonemella americana*
Bryoria nitidula	*Hypogymnia subobscura*	*Stereocaulon arenarium*
Bryoria trichodes ssp. *trichodes*	*Lasallia pensylvanica*	*Stereocaulon botryosum*
Catolechia wahlenbergii	*Lempholemma cladodes*	*Stereocaulon capitellatum*
Cetraria delisei	*Lempholemma intricatum*	*Stereocaulon coniophyllum*
Cetraria nigricans	*Lempholemma radiatum*	*Stereocaulon depressum*
Cladonia coccifera	*Leptogidium dendriscum*	*Stereocaulon glareosum*
Cladonia cyanipes	*Leptogium cyanescens*	*Stereocaulon pileatum*
Cladonia macroceras	*Leptogium plicatile*	*Stereocaulon symphycheilum*
Cladonia macrophylla	*Leptogium pseudofurfuraceum*	*Sticta arctica*
Cladonia pseudalcicornis	*Leptogium tenuissimum*	*Sticta oroborealis*
Cladonia singularis	*Lichinodium canadense*	*Sticta wrightii*
Cladonia subfurcata	*Lobaria retigera*	*Umbilicaria aprina*

(continued)

Table 3.1-1. Rare Plant Surveys: Target Lichens Species (completed)

Cladonia trassii	*Lobaria silvae-veteris*	*Umbilicaria cinereorufescens*
Coelocaulon muricatum	*Masonhalea olivaceoides*	*Umbilicaria decussata*
Collema auriforme	*Nephroma helveticum* ssp. *helveticum*	*Umbilicaria krascheninnikovii*
Collema coniophilum	*Nephroma isidiosum*	*Umbilicaria lambii*
Collema crispum	*Nodobryoria subdivergens*	*Umbilicaria leiocarpa*
Collema cristatum	*Parmelia skultii*	*Umbilicaria lyngei*
Collema flaccidum	*Parmeliella parvula*	*Umbilicaria nylanderiana*
Collema glebulentum	*Peltigera degenii*	*Usnea cavernosa*
Collema multipartitum	*Peltigera evansiana*	*Usnea glabrescens*
Collema sp. nov.	*Peltigera gowardii*	*Vahliella leucophaea*
"Dendriscocaulon" amplissimum	*Phaeophyscia* cf. *nigricans*	*Vestergrenopsis elaeina*
"Dendriscocaulon" oroboreale	*Physcia stellaris*	*Zahlbrucknerella calcarea*
"Dendriscocaulon" wrightii	*Pilophorus robustus*	

Table 3.1-2. Rare Plant Surveys: Target Moss Species

Andreaea rupestris var. *papillosa*	*Lescuraea saxicola*	*Psilopilum cavifolium*
Brachytheciastrum trachypodium	*Mielichhoferia elongata*	*Ptychostomum arcticum*
Bryhnia hultenii	*Mielichhoferia miehlichhoferiana*	*Sarmentypnum pseudosarmentosum*
Bryoerythrophyllum ferruginascens	*Mnium arizonicum*	*Schistidium boreale*
Bryum calobryoides	*Myurella sibirica*	*Sphagnum annulatum*
Cinclidium arcticum	*Niphotrichum panschii*	*Sphagnum aonstroemii*
Dicranodontium asperulum	*Niphotrichum pygmaeum*	*Sphagnum contortum*
Didymodon asperifolius	*Oreas martiana*	*Sphagnum obtusum*
Didymodon johansenii	*Orthothecium strictum*	*Sphagnum subobesum*
Didymodon leskeoides	*Orthotrichum pylaisii*	*Steerecleus serrulatus*
Diphyscium foliosum	*Orthotrichum rivulare*	*Tayloria froelichiana*
Encalypta brevicollis	*Philonotis yezoana*	*Tetradontium brownianum*
Encalypta brevipes	*Plagiobryum demissum*	*Tetraplodon pallidus*
Entodon concinnus	*Pleuroziopsis ruthenica*	*Timmia norvegica*
Hageniella micans	*Pohlia cardotii*	*Tortula leucostoma*
Helodium paludosum	*Pohlia columbica*	*Tortula systylia*
Hygrohypnum alpestre	*Pohlia crudoides*	*Ulota curvifolia*
Hygrohypnum alpinum	*Pohlia elongata*	*Warnstorfia pseudostraminea*
Hygrohypnum polare	*Pohlia sphagnicola*	*Warnstorfia trichophylla*
Hypnum holmenii	*Pseudobryum cinclidoides*	*Warnstorfia tundrae*
Isopterygiopsis muelleriana	*Pseudocalliergon turgescens*	

Table 3.1-3. Rare Plant Surveys: Target Vascular Plant Species

Arctanthemum arcticum	*Draba lactea*	*Oxytropis maydelliana*
Botrychium alaskense	*Draba palanderiana*	*Packera ogotorukensis*
Botrychium ascendens	*Draba porsildii*	*Papaver alboroseum*
Botrychium crenulatum	*Draba ruaxes*	*Pedicularis parviflora*
Botrychium montanum	*Draba stenopetala*	*Pedicularis verticillata*
Botrychium pedunculosum	*Draba ventosa*	*Pinguicula villosa*
Caltha palustris var. *radicans*	*Draba* sp. nov.	*Polemonium boreale*
Carex backii	*Dryopteris cristata*	*Polemonium elegans*
Carex bicolor	*Epilobium davuricum*	*Polystichum kruckebergii*
Carex enanderi	*Epilobium halleanum*	*Primula cuneifolia*
Carex incurviformis	*Epilobium hornemanii* ssp. *behringianum*	*Ranunculus occidentalis* var. *hexasepalus*
Carex krausei		
Carex lenticularis var. *lenticularis*	*Epilobium leptocarpum*	*Sagina nivalis*
Carex membranacea	*Erigeron uniflorus*	*Salix raupii*
Carex misandra	*Eutrema edwardsii*	*Saxifraga serpyllifolia*
Carex rostrata	*Festuca minutiflora*	*Senecio sheldonensis*
Carex rupestris	*Gentianella tenella*	*Silene involucrata*
Carex tenera	*Geum rossii*	*Silene ostenfeldii*
Castilleja hyperborea	*Glyceria pulchella*	*Tephroseris frigida*
Cicuta virosa	*Gymnocarpium jessoense*	*Tephroseris lindstroemii*
Cornus suecica	*Juncus albescens*	*Tephroseris yukonensis*
Douglasia gormanii	*Juncus arcticus* ssp. *alaskanus*	*Tofieldia coccinea*
Draba cinerea	*Juncus stygius*	*Trichophorum pumilum*
Draba corymbosa	*Lomatogonium rotatum*	*Woodsia alpina*
Draba fladnizensis	*Luzula confusa*	*Pinguicula villosa*
Draba glabella	*Luzula groenlandica*	*Polemonium boreale*
Draba lactea	*Luzula kjellmaniana*	
Draba palanderiana	*Luzula nivalis*	
Douglasia gormanii	*Malaxis brachypoda*	
Draba cinerea	*Micranthes nelsoniana* var. *carlottae*	
Draba corymbosa	*Micranthes nelsoniana* var. nov.	
Draba fladnizensis	*Minuartia arctica*	
Draba glabella	*Minuartia stricta*	

3.2 IDENTIFICATION OF TARGET HABITAT FOR RARE PLANT AND LICHEN SURVEYS

Most rare species are rare because they require rare habitats. As such, the survey effort focused mainly on uncommon habitat types such as marshes, fens, river shores and backwaters, scree, cliffs, gravel bars, pond and lake shores, seasonal pools, creek shores, seepages and other wetland habitats.

3.3 RARE PLANT AND LICHEN SPECIES FOUND WITHIN THE LOCAL STUDY AREA

Seventy-six rare plant and lichen species were identified during the 2012-2013 surveys, consisting of 19 vascular plant, 42 lichen and 15 moss species (Tables 3.3-1 to 3.3-4; Figure 3.3-1). Of these, 59 species listed by the BC CDC were identified in the LSA, including 34 macrolichens, 13 vascular plants, and 12 mosses. Of the seventeen species considered rare but previously undocumented in British Columbia, new to science or ranked as SU (i.e., uncertain by the BC CDC), six are vascular plants, eight are lichens, and three are mosses. None of the rare species found are currently listed under SARA or by COSEWIC however one species is on the candidate list for the SARA. In total, 231 tracked species occurrences (element occurrences) were recorded.

Table 3.3-1. Summary of Rare Plant and Lichen Species Found in the Local Study Area

Conservation Rank	Vascular Plants	Lichens	Mosses
S1 (Red-listed)	0	8	0
S1S2 (Red-listed)	0	3	4
S1S3 (Red-listed)	3	0	0
S2 (Red-listed)	0	5	2
S2S3 (Blue-listed)	7	10	2
S2S4 (Blue-listed)	0	1	0
S3 (Blue-listed)	3	6	4
S3? (Blue-listed)	0	1	0
SARA	0	0	0
Non-Listed Rare Species	6	8	3
Total	**19**	**42**	**15**

[1]*Includes species previously undocumented in British Columbia, new to science or ranked as SU.*

Table 3.3-2. Rare Lichens Identified in the Local Study Area

Lichen Name	NatureServe and BC CDC Ranks
Allantoparmelia almquistii	S3; Blue-listed
Arctoparmelia incurva	S2S3; Blue-listed
Baeomyces carneus	S1; Red-listed
Bryocaulon hyperboreum	Not ranked, previously undocumented in BC
Bryoria nitidula	S2S3; Blue-listed
Cetraria delisei	S3; Blue-listed
Cetraria nigricans	S3; Blue-listed
Cladonia coccifera	S1; Red listed
Cladonia macrophylla	S2; Red-listed
Cladonia pseudalcicornis	S2S3; Blue-listed
Cladonia singularis	S3; Blue-listed
Cladonia subfurcata	S2S3; Blue-listed
Collema ceraniscum	S1; Red-listed
Collema crispum	S1, Red-listed
Collema cristatum var. *marginale*	S2; Blue-listed
Collema glebulentum	S2S3; Blue-listed
Collema sp. nov.	Not ranked, a species new to science, known only from the Project area
Dermatocarpon leptophyllodes	S2S4; Blue-listed

(continued)

Table 3.3-2. Rare Lichens Identified in the Local Study Area (completed)

Lichen Name	NatureServe and BC CDC Ranks
Fuscopannaria cheiroloba	A rare species known from very few populations in its rather limited range
Hydrothyria venosa s. lat.	S1S2; Red-listed
Lempholemma intricatum	S1S2; Red-listed
Leptogium cyanescens	S1; Red-listed
Leptogium imbriactum	Not ranked, previously undocumented in BC (previous reports from BC have proven incorrect)
Nodobryoria subdivergens	S2S3; Blue-listed
Parmelia skultii	S1; Red-listed
Phaeophyscia cf. *nigricans*	*Phaeophyscia nigricans* is ranked S1; Red-listed- see rare plant report for additional rank information on this species
Placynthium asperellum	S3?; Blue-listed
Solorina bispora	S2S3; Blue-listed
Solorina octospora	S3; Blue-listed
Solorina spongiosa	S2; Red-listed
Sphaerophorus fragilis	S2S3, Blue-listed
Steineropsis alaskana	Not ranked, newly discovered for BC, globally rare
Stereocaulon arenarium	S2; Red-listed
Stereocaulon botryosum	S2; Red-listed
Stereocaulon capitellatum	S1; Red-listed
Stereocaulon depressum	S1; Red-listed
Stereoculon glareosum	S2S3; Blue-listed
Stereocaulon symphycheilum	S1S2; Red-listed
Umbilicaria lambii	S3; Blue-listed
Umbilicaria sp. nov.	Not ranked; a new species known only from the Project area
Vahliella leucophaea	Not ranked; previously undocumented in BC
Vestergrenopsis elaeina	S2S3; Blue-listed

Table 3.3-3. Rare Mosses Identified in the Local Study Area

Moss Species	NatureServe and BC CDC Ranks
Amblyodon dealbatus	S3; Blue-listed
Andreaea sinuosa	S2; Red-listed
Bryum calobryoides	S1S2; Red-listed
Dicranum montanum	S3; Blue-listed
Helodium paludosum	Not ranked, but otherwise known in BC from only two localities
Mielichhoferia elongata	Not ranked, but the present population is apparently the only one documented thus far from British Columbia; said in literature to be globally rare, though this is not reflected by the perhaps erroneous NatureServe rank of G4 (NatureServe 2012)
Plagiobryum demissum	S1S2; Red-listed
Pohlia cardotii	S2; Red-listed
Pohlia sp. nov.	Not ranked, a rare new species
Psilopilum cavifolium	S1S2; Red-listed
Ptychostomum schleicheri	S2S3; Blue-listed

(continued)

Table 3.3-2. Rare Lichens Identified in the Local Study Area (completed)

Moss Species	NatureServe and BC CDC Ranks
Sarmentypnum pseudosarmentosum	S3; Blue-listed
Sphagnum annulatum	S1S2; Red-listed
Sphagnum aongstroemii	S2S3; Blue-listed
Tomentypnum falcifolium	S3; Blue-listed

Table 3.3-4. Rare Vascular Plants Identified in the Local Study Area

Vascular Plant Species	NatureServe and BC CDC Ranks
Antennaria howellii × *alpina*	Not ranked, an anomalous taxon not previously known to science
Botrychium crenulatum	S2S3; Blue-listed
Carex enanderi	S2S3; Blue-listed
Carex praeceptorum	S1S3; Red-listed
Carex rostrata × *utriculata*	S2S3; Blue listed (rank of *C. rostrata*)
Carex sp. nov.	Not ranked, previously misreported as *Carex atrata*
Draba glabella	S2S3; Blue-listed
Draba sp. nov.	Not ranked; a rare new species known only from the northern BC Coast Ranges
Epilobium davuricum	S1S3; Red-listed
Epilobium hornemannii ssp. *behringianum*	S2S3; Blue-listed
Epilobium leptocarpum	S2S3; Blue-listed
Epilobium x treleasianum	S3; Blue-listed
Gymnocarpium jessoense ssp. *parvulum*	S3; Blue-listed
Micranthes nelsoniana var. *carlottae*	S3; Blue-listed
Micranthes nelsoniana var. nov.	Not ranked; a rare plant new to science
Polypodium cf. *interjectum*	Not ranked, a possible taxonomic novelty, rare
Ranunculus occidentalis var. *hexasepalus*	S1S3; Red-listed
Woodsia alpina	S2S3; Blue-listed

Currently, none of the documented rare species are listed under SARA; however, several species are considered rare world-wide according to NatureServe (NatureServe 2012)). NatureServe's G ranks represent the overall status of a species at a global level. Six species with G ranks ranging from G2G3 through G3G4 threatened, sensitive or possibly sensitive were identified. These include *Bryum calobryoides* (G3), *Nodobryoria subdivergens* (G2G3), *Pohlia cardotii* (G2G3), *Sphagnum aongstroemii* (G3G4), *Stereocaulon symphycheilum* (G3), and *Umbilicaria lambii* (G2G4). Furthermore, the Natureserve system has completed G ranks for only a portion of the total North American flora, so many of the globally rare species on the continent are not yet flagged as conservation priorities. For example, *Bryocaulon hyperboreum, Cladonia pseudalcicornis, Cladonia singularis, Cladonia subfurcata, Fuscopannaria cheiroloba, Lempholemma intricata,* and *Ranunculus occidentalis* var. *hexasepalus* are not assigned global conservation ranks, but are so seldom reported and are likely of global-scale conservation priority.

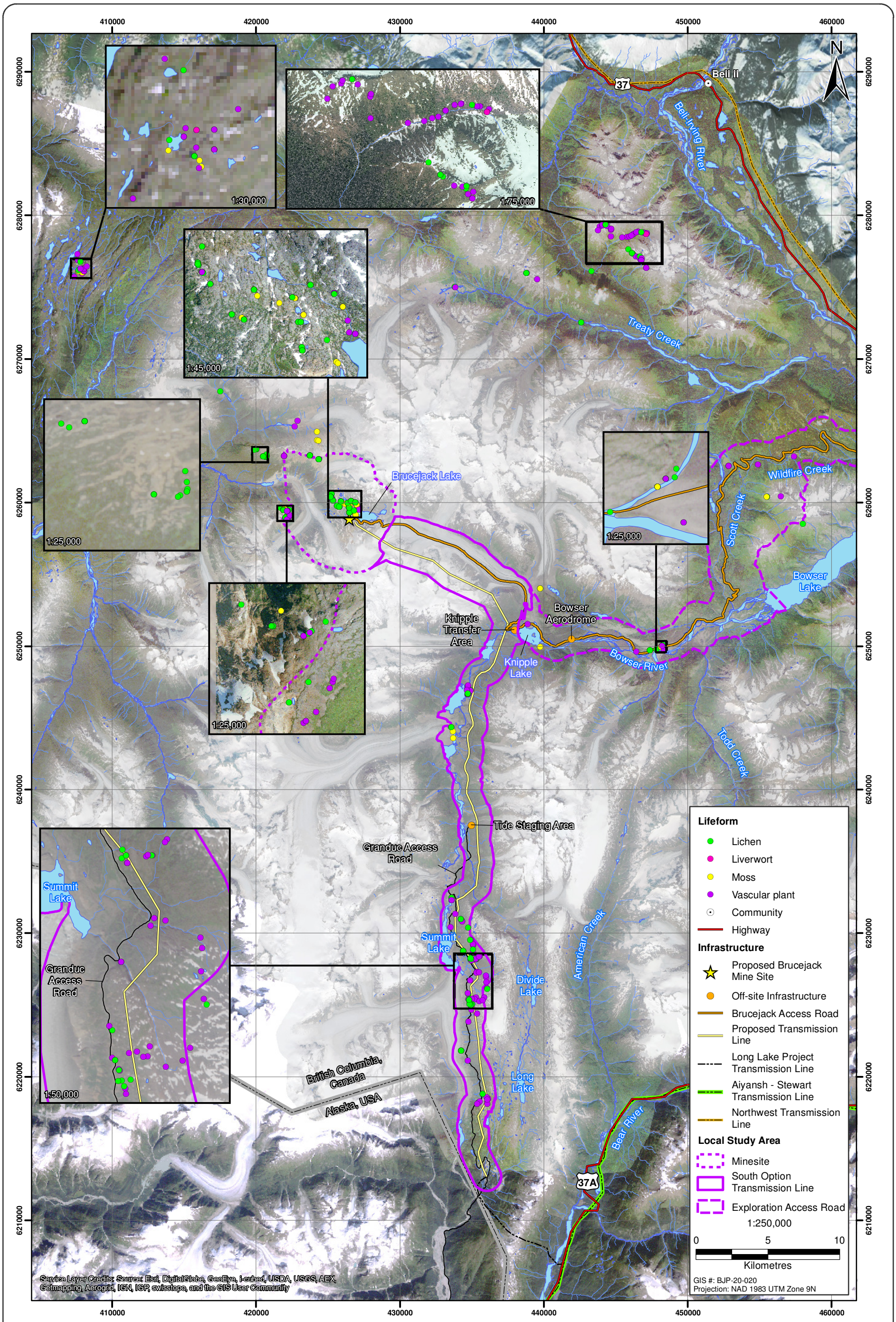

Figure 3.3-1

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Rare Plant and Lichen Observations in the Brucejack Local and Regional Study Areas

Figure 3.3-1

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Additionally, the species new to science that are known only from the Project or from few populations elsewhere in the BC Coast Ranges may also merit global-scale conservation ranking, including Carex sp. nov., Collema sp. nov., Draba sp. nov., Micranthes nelsoniana var. nov., and Umbilicaria sp. nov.

Some species encountered in the 2012 surveys that were previously thought rare are now known to be too common to merit conservation ranking at the present time, including Castilleja unalaschcensis, Drepanocladus aduncus, Lempholemma polyanthes, Leptogium plicatile sensu lato, Phaeophyscia decolor, Physcia dubia, and Saxifraga oppositifolia ssp. smalliana. These species are not given further consideration here as conservation priorities. Additionally, some species found are only tentatively identified as rare taxa. Though these species were preliminary highlighted as rare and listed taxa following the field surveys, additional research on these specimens revealed that their identities are currently too much in doubt to be highlighted as rare and listed taxa. These include Cinclidium subrotundum, Dicranum flagellare, Dicranum montanum, Gemmabryum subapiculatum, Imbribryum gemmiparum, Leciophysma furfurascens, Niphotrichum pygmaeum, Schistidium atrichum, Stereocaulon arcticum, and Umbilicaria aprina.

3.4 RARE PLANT HABITAT WITHIN THE LOCAL STUDY AREA AND THE SURROUNDING AREA

Most rare plants were found in open, non-forested areas, or where forest canopy cover is light. Some rare species were found in the shade of trees, but the habitat characteristics significant to these species are associated with special habitat features such as cliffs, rock outcrops or ecotonal areas between forested and unforested habitat. Among non-forested habitats, some were found to have overall high species richness and numerous rare plants and lichens. Rare plant habitat types are listed in Table 3.4-1 and described in the following sections.

Table 3.4-1. Rare Plant Habitat Types within the Local Study Area

Alpine	Non-alpine
Cliffs	Fens
Ephemeral pools	Gossen Outcrops
Moist Meadow	Lakeshores
Rock Pinnacles	Marshes
Scree	River Back-Channels and Gravel Bars
Stable Rocky Tundra	Talus

3.4.1 Alpine Cliff Habitats

Cliffs present diverse microhabitat settings due to, slope, aspect, variation in rock chemistry and texture, light exposure, presence of soil pockets on ledges and in crevices, wind shelter or exposure, and seepage hydrology and seepage-deposited mineral precipitates, as well as nutrient availability (varying with exposure to rain-wash, dust accumulations, or guano deposits; Plate 3.4-1). A major portion of the plants and lichens of British Columbia rely on various combinations of these ecological characteristics in cliff ecosystems, and few of them are among the dominant or widespread of the province.

Species adapted to growing on cliffs are generally small, compact and slow growing, making them poor competitors that cannot maintain niches in dense vegetation. But the complement to the habitat limitations due to poor competitive ability is that on cliffs, these species are competing only against other minimally competitive species. Hence, the communities of plants and lichens on cliffs tend to have a hold on their habitat for long periods of time. Because cliffs cannot be drastically altered by growth of a forest canopy or dense shrub growth, cliff habitats present stable conditions for long periods of time. Species accumulation is a slow process, but so is species loss from these habitats. Cliff vegetation is therefore populated by suites of uncommon species living on habitat islands, geographically isolated and often regionally or globally rare.

Plate 3.4-1. Example of an alpine cliff ecosystem in the LSA.

Rare species found in the LSA on alpine cliff habitats include *Bryum calobryoides, Collema ceraniscum, Collema glebulentum, Draba glabella, Draba* sp. nov., *Lempholemma intricatum, Leptogium imbricatum, Phaeophyscia cf. nigricans, Placynthium asperellum, Plagiobryum demissum, Solorina bispora, Solorina octospora, Stereocaulon botryosum, Stereocaulon depressum, Stereocaulon symphycheilum, Vestergrenopsis elaeina,* and *Woodsia alpina. Parmelia skultii, Pohlia cardotii,* and *Sphagnum aongstroemii* were found in cliff ecosystems also, but only on ground at the bases of seepy cliff ecosystems.

3.4.2 Alpine Ephemeral Pool Habitats

Ephemeral pools in alpine tundra are a special habitat occupied by very few species of poor competitive ability, such as *Juncus biglumis*. These are small plants adapted to the variable hydrology of ephemeral pools, where they are periodically flooded during snowmelt and rain events, then drying, sometimes for prolonged periods between rainfall events. Few alpine plants can withstand this alternating flooding/desiccating cycles. Only one rare species that relies on this habitat was found in the Project area, *Sarmentypnum pseudosarmentosum*. An example to an alpine ephemeral pond is illustrated in Plate 3.4-2.

3.4.3 Alpine Moist Meadow Habitats

Moist alpine meadows were found to be a special habitat for numerous species found in no other habitat nearby. Among these were two conservation priority species, *Antennaria howelli* × *alpina* and *Ranunculus occidentalis* var. *hexasepalus*. The meadow depicted below is formed on an alluvial fan by the shore of Brucejack Lake by the fine outwash material from creeks cascading down an adjacent mountain side (Plate 3.4-3). Unlike most of the alpine habitats in the area, the soils of the meadow are relatively fine and deep, and are kept moist by the numerous inflowing creeks. Alluvial fans are a rare feature at alpine elevations in the BC Coast Ranges.

Plate 3.4-2. Alpine ephemeral pool habitat in the LSA.

Plate 3.4-3. Moist alpine meadow near the shore of Brucejack Lake.

3.4.4 Alpine Rock Pinnacles

On ridges northwest from Brucejack Lake, a few rock pinnacles were found in rocky tundra (Plate 3.4-4). These pinnacles jut about 1-2 m above the surrounding ground. They were found to be substrate for a number of uncommon lichens, including the rare species *Allantoparmelia almquistii, Sphaerophorus fragilis, Stereocaulon botryosum, Stereocaulon symphycheilum, Umbilicaria lambii,* and *Umbilicaria* sp. nov. These species were all lacking from nearby rock surfaces. The pinnacles did not appear to be chemically different (no calciphiles, not appearing iron-rich or rich in other metals), from surrounding rocks. Presumably, the distinction of these pinnacles as habitat would be due to their being elevated above near-ground boundary layers, where wind speeds are greatly slowed, humidity and moisture more ephemeral, and perhaps where snowmelt occurs earlier.

Plate 3.4-4. Alpine rock pinnacles, northwest of Brucejack Lake, provide special habitat for numerous rare lichen species.

3.4.5 Alpine Scree

Scree refers to slopes of more or less loose, sliding stone material of gravel (fine scree) to boulder (course scree, or talus) particle size. Alpine fine scree was found to be habitat for numerous unusual species in the study area, including some of the most visually attractive alpine plants. This habitat is unusual in having minimal soil development, but great potential rooting depth (Plate 3.4-5). Plants on fine scree are often long-lived, with very long taproots that allow subterranean contraction of the plant tip in winter or during drought periods. Germination success may be very low on scree, as few seedlings are able to grow their roots fast enough down into the substrate to reach stable moisture sources, since after germination, the upper layers of scree may dry more rapidly than a seedling's root can grow. Low germination success leads to sparse plant cover on fine scree, and low competition pressure. Therefore, fine scree can actually be a stable habitat despite its unstable, sliding material; dense competitive vegetation is unable to establish, allowing minimally competitive and rare species are able to persist for long periods of time in stable though constantly disturbed populations. Rare species found on fine scree in the study area include *Draba ruaxes, Polemonium elegans* and *Stereocaulon glareosum*.

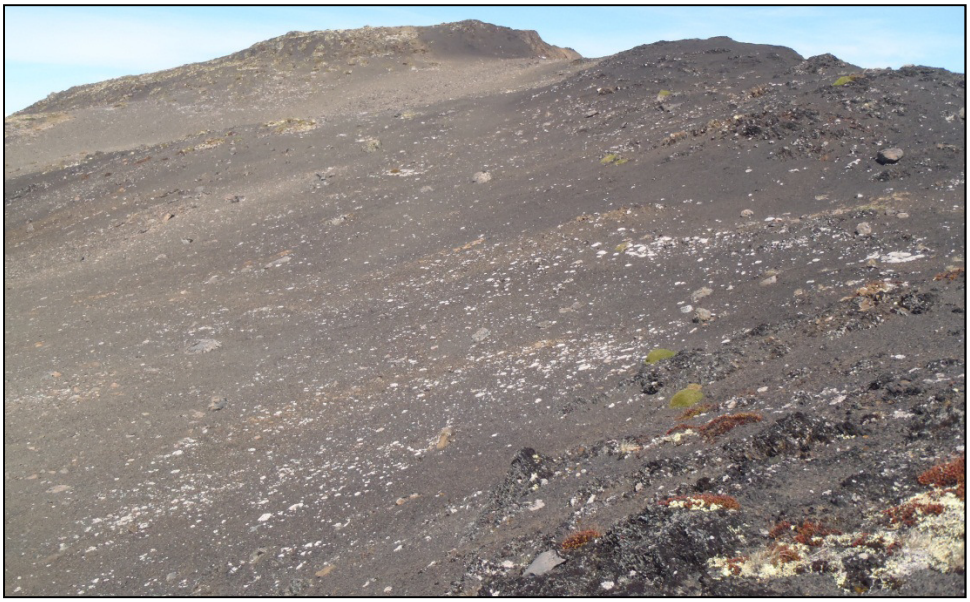

Plate 3.4-5. Fine scree habitat, photographed in the Local Study Area.

3.4.6 Alpine Rocky Tundra

Stable alpine tundra is a complex mix of habitats characterized by their relatively stable geology. This is in contrast to the ice-covered, recently deglaciated, or steeply sloped and fast-eroding habitats that are dominant over most of the alpine portion within the surrounding area (Plate 3.4-6). Stable tundra, while overwhelmingly dominant in arctic environments, is relatively uncommon in alpine environments. Much of the rocky tundra in the project area resembles arctic tundra in its rocky, thin soils and widespread exposures of surface bedrock and weathered rock faces. Many of the rare species documented are more common in arctic tundra than in British Columbia, a testament to the uncommon occurrence of this habitat type in the province.

Plate 3.4-6. Stable, rocky tundra habitat (foreground), in contrast to fast-eroding or ice-covered alpine habitats visible in the background. Photographed in the Local Study Area.

Stable tundra in the LSA includes various microhabitats that vary with soil depth, moisture availability, seepage and surface stream flow, winter snow depth, slope and aspect. Most of the stable tundra observed during the 2012 rare plant surveys occurs on broad, gentle ridges, where wind exposure may keep the winter snowpack relatively thin. Thin snowpack is a crucial requirement for many tundra-dwelling species, particularly lichens, many of which are intolerant of the suffocating conditions of prolonged periods of poor oxygen availability during the lengthy spring-early summer snowmelt.

Rare species located in the 2012 rare plant surveys in stable tundra habitats include *Arctoparmelia incurva, Bryocaulon hyperboreum, Bryoria nitidula, Carex* sp. nov.*, Cetraria delisei, Cetraria nigricans, Cladonia pseudalcicornis, Cladonia subfurcata, Draba ruaxes, Nodobryoria subdivergens, Pohlia cardotii, Psilopilum cavifolium,* and *Umbilicaria lambii*.

3.4.7 Cliffs (Low Elevation)

Low elevation cliffs, like their counterparts in the alpine, present diverse microhabitat settings due small-scale variation in slope, aspect, rock chemistry and texture, light exposure, presence of soil pockets on ledges and in crevices, wind shelter or exposure, seepage hydrology, seepage-deposited mineral precipitates, and nutrient availability (varying with exposure to rain-wash, dust accumulations, or guano deposits; Plate 3.4-7). A major portion of the plants and lichens of British Columbia rely on various combinations of these ecological characteristics in cliff ecosystems, and few of them are among the dominant or widespread of the province.

Plate 3.4-7. Low-elevation cliff habitat photographed in the Local Study Area.

Species adapted to growing on cliffs are generally small, compact and slow growing, making them poor competitors that cannot maintain niches in dense vegetation. But the complement to the habitat limitations due to poor competitive ability is that on cliffs, these species compete only against other minimally competitive species. Hence, the communities of plants and lichens on cliffs tend to have a hold on their habitat for long periods of time. Because cliffs cannot be drastically altered by growth of

a forest canopy or dense shrub growth, cliff habitats present stable conditions for long periods of time. Species accumulation on cliffs is a slow process owing to difficulty successful dispersal to and establishment on them, but species that manage to establish on these habitats can maintain a long-term hold there. Cliff vegetation is therefore populated by suites of uncommon species living on habitat islands, geographically isolated and often regionally or globally rare.

Rare species found in the LSA on low-elevation cliffs include *Cladonia coccifera, Collema crispum, Collema cristatum, Dermatocarpon leptophyllodes, Draba glabella, Draba* sp. nov., *Fuscopannaria cheiroloba, Lempholemma intricatum, Leptogium cyanescens,* and *Vahliella leucophaea.*

3.4.8 Wetland Fens

Fens are nutrient rich wetlands that experience some amount of lateral flow. The open water component varies throughout the year, thus allowing for the creation of extensive transitional ecotones. Numerous fens occur on plateaus at middle and upper elevations in the LSA. They were found to have modest plant species richness with a few occurrences of rare species. In particular two listed species, *Epilobium leptocarpum* and *Sphagnum annulatum* were identified in fens, and another, *Micranthes nelsonii* var. nov. was found in the transitional ecotone between a fen and forest habitat (Plate 3.4-8).

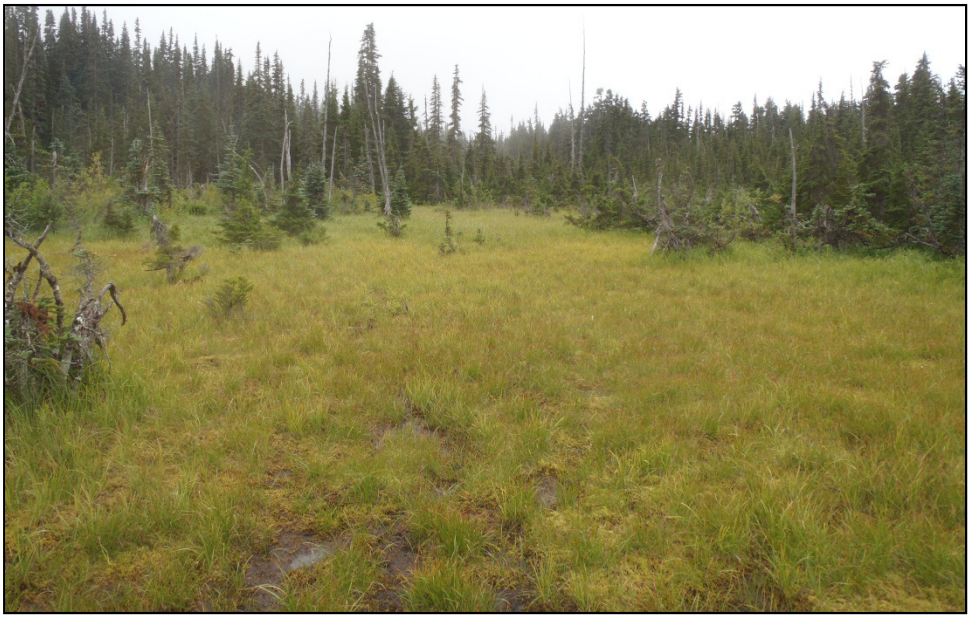

Plate 3.4-8. Fens provided habitat for rare plants such as Epilobium leptocarpum.

3.4.9 Gossen Outcrops

Gossen is metalliferous, siliceous, rock coloured orange, reddish or purplish by iron oxide (Plate 3.4-9). Few plants can tolerate the strongly acidic soils derived from this rock type, so gossen is often sparsely vegetated. There is however a small number of plants and lichens specially adapted to the acidic conditions and metal ions present on gossen and other strongly metalliferous rocks, including for example *Acarospora sinopica*, a lichen that has received conservation attention in Canada, once considered for listing under the *Species at Risk Act* (Brodo, pers. comm. 2010; Plate 3.4-10). It is however not highlighted as a conservation concern in the present study due to its status as a microlichen (microlichens do not yet receive conservation listing in British Columbia). The only conservation-status species found on gossen outcrops in the 2012 rare plant survey was *Mielichhoferia elongata*. That species and others in its genus have been colloquially named “copper mosses” for their presumed affinity towards copper, but they only require strongly acidic rocks, whether copper-containing or not (Wilkins 1977).

Plate 3.4-9. Gossen is metalliferous, siliceous, rock coloured orange, reddish or purplish by iron oxide.

Plate 3.4-10. Gossen outcrops provide habitat for acid tolerant lichen species such as Acarospora sinopica.

3.4.10 Lakeshores

Lake and pond shores are often habitat for numerous rare species. However, the pond and lake shorelines studied in the LSA were found to have only a single rare species: *Carex rostrata* × *utriculata*

(Plate 3.4-11). This may be due to the type of shorelines, which are often scoured or rocky. The shores of Bowser and Knipple Lakes for example, are mostly very steep and rocky, with little soil development, and perhaps too little time has passed since valley glaciers retreated from the valley of these lakes for there to have been much development of plant diversity.

Plate 3.4-11. An example of a pond shore that provides habitat for the rare Carex rostrata × utriculata (illustrated here).

3.4.11 Wetland Marshes

Marshes are wetlands characterized by mineral soils and low species diversity. They occupy the margins of lakes, rivers and creeks, and almost always experience some amount of late season drawdown of the water table. A single marsh was surveyed in the 2012 rare plant surveys, in the Scott Creek headwaters (Plate 3.4-12). Variation of soils and plant species composition was observed in this complex, due to annual flooding resulting in the accruing of sediment. The soil in some portions is discoloured by iron oxides, and in other areas, calciphilic plants were observed that suggest higher pH soils. One of the dominant species in the fen is the rare *Carex rostrata* × *utriculata*. Other rare species observed there are the mosses *Helodium paludosum* and *Tomentypnum falcifolium,* and the vascular plant *Epilobium davuricum*.

3.4.12 River Back-Channels and Gravel Bars

The Bowser River presented an abundance of habitats for rare plants. Noteworthy for plant diversity were the open, sparsely treed gravel bars (Plate 3.4-13) near the active channels of the river, and the cobbles of a rarely flooded back-channel (Plate 3.4-14). The braided channels of the Bowser River vary greatly in soil texture, with fine and coarse materials sorted into silty, sandy, gravelly and cobbly sections. Associated with this variation was a noteworthy variation in plant cover. Silty areas are generally densely vegetated with tree and shrub cover, where overall plant diversity was found to be low, and where no rare species were found. Gravelly and sandy sections were very rich in species wherever tree and shrub cover was minimal. The rare lichen *Cladonia singularis* was found in this habitat. Cobbly and silty back channels that are flooded only during the highest water were also found to be rich in plant species, and found there was the rare cobble-dwelling lichen *Collema* sp. nov. (though generally lichen diversity is low in these back channels except for epiphytic species on older trees adjacent to the channels—few lichens are tolerant of flooding).

Plate 3.4-12. An example of a marsh/fen complex in the LSA (the large marsh complex in the Scott Creek headwaters).

Plate 3.4-13. Sparsely treed gravel bars contained high species diversity.

Plate 3.4-14. An example of a rarely flooded back-channel that contained high species diversity.

3.4.13 Talus

While scree can be formed of gravel to boulder sized particles, talus specifically refers to slopes of loose large rocks (Plate 3.4-15). Talus is an important habitat for many mosses, lichens and some vascular plants, partly owing to balch ventilation, the entrapment of denser, colder air in the interspaces between the rocks (Putnam & Putnam 2009). Balch ventilation creates a distinct cool air mass with a sharp boundary at the talus surface, and can often be felt by reaching an arm below surface layer of rocks. This cool air layer buffers heat-intolerant lichens and plants, allowing them to persist where the local climate is unfavourably warm. Additionally, talus slopes cannot become densely vegetated in trees and shrubs, so the less competitive lichens, mosses and small, slow growing plants can persist there for long periods of time without getting shaded out. Thus, a talus slope can accumulate uncommon and rare species, resulting in high species diversity.

Many uncommon species were found in the single talus slope habitat encountered during surveys including one rare species, *Stereocaulon botryosum*. Certain species identified merit special mention, though they are currently unrankable or their identities cannot currently be confirmed and so cannot be highlighted as conservation priorities. A number of specimens collected during the surveys are similar in some key characteristics to known rare species, but with significant differences. In some cases, these may be correctly placed in those tracked species and the delimitations of those species would be thus expanded. In other cases, these may be best assigned to common species, or may represent previously unknown undescribed species. These include, for example, *Bryoria kockiana* ined., *Bucklandiella affinis*?, *Cladina* (unknown species, K+ and KC+ yellow), *Cladina cf. rangiferina* (but branching in twos), *Cladonia cf. maxima*, *Gemmabryum subapiculatum*?, *Imbribryum gemmiparum?*, *Leciophysma furfurascens*? (but with Scytonema), *Peltigera lyngei*?, *Umbilicaria aprina*? and many others.

Plate 3.4-15. Talus habitat along the old Bowser River Road.

The finding of such entities in the study area serves to highlight how imperfect and incomplete is the understanding of the very rich British Columbia flora. While outside the scope of this study, much more work remains to refine the taxonomy of north-temperate and boreal plants, a fact perhaps underappreciated in the botanical and lichenological communities.

3.5 SUMMARY AND RECOMMENDATIONS

The 2012 and 2013 rare plant and lichen surveys in the proposed Brucejack Gold Mine Project Local Study Area (LSA) and surrounding area resulted in the detection of a large number of conservation-priority species, some of which are thought to be of high global priority due to their world-wide rarity, habitat limitations, small populations, vulnerability to extirpation, or other considerations. Rare species populations were found throughout the study area in localized habitats such as cliffs, rock pinnacles, scree, gossen outcrops, stable tundra, back river channels, gravel bars and wetland habitats.

The results of this study provide important information on plant and lichen biodiversity in the northern Coast Ranges, including the discovery and documentation of species new to science[1], geographical range extensions and species habitat specificity. Additionally, based on the results of this survey, a number of species, tracked by the BC CDC, were found so commonly that they merit a change/re-assessment of rank status.

[1] These species are considered rare, at least until their distribution and in some cases taxonomy are better understood.

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Appendix 8-1

Species Accounts of Rare Plants and Lichens Documented in the LSA

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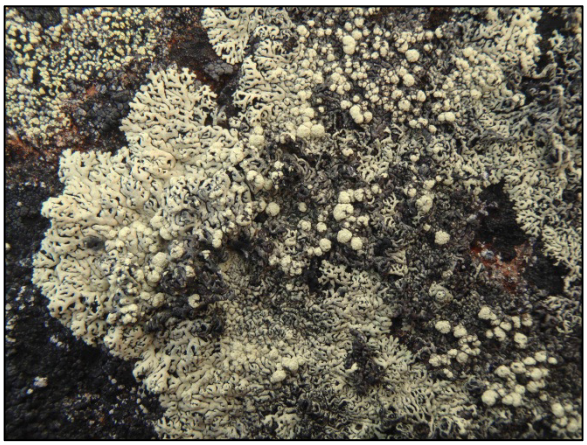
Appendix 8-1. Species Accounts of Rare Plants and Lichens Documented in the LSA

Allantoparmelia almquistii (Vainio) Essl.	**LICHEN**
	Conservation Rank: S3; Blue listed.
	Habitat: On acidic rock faces on wind-blown ridgetops, alpine. Found in the project area on cliffs and rock pinnacles on alpine promontories.
	This species differs from other foliose, alpine, rock-dwelling lichens in its convex but non-inflated lobes, lack of rhizines (root-like structures), light brown lower surface, narrow lobes, and its production of olivetoric acid (Goward et al. 1994). Photo from Nunavut.

Antennaria howellii E. Greene x A. alpina (L.) Gaertn.	**VASCULAR PLANT**
	Conservation Rank: Not ranked, an anomalous taxon not previously known to science.
	Habitat: Moist alpine meadow.
	The characteristics of this plant are not only unique within the genus, but they are intermediate between two major evolutionary lineages, the *A. howellii* and *A. alpina* complexes. No hybrids between these have ever been noted, and would not have been expected since the species of these complexes do not grow in the same habitats. The former is of low-elevation grassland and dry forest, the latter of alpine and subalpine elevations. Like *A. howellii* this plant has long, lax leafy runners and broad leaves that are at first silvery, but age to a greenish colour on the upper surface; like *A. alpina,* this plant has dark greenish brown floral bracts and an alpine meadow habitat. More work is needed to determine whether the population represents a new species. Photo from the Project area.

Arctoparmelia incurva (Pers.) Hale	LICHEN
	Conservation Rank: S2S3; Blue listed.
	Habitat: On acidic rocks, alpine. Found in the Project area on alpine rock faces.
	This species is easily identified based on its cream-coloured lobes (colouration due to usnic acid) that lack any gloss due to a weak polysaccharide layer, and spherical soralia (which bear soredia, dust-like asexual reproductive structures; Goward et al. 1994). Photo from the Northwest Territories.

Bryocaulon hyperboreum Øvstedal	LICHEN
	Conservation Not ranked; previously undocumented in BC.
	Habitat: Open, rocky tundra, arctic-alpine.
	From the more common and widespread *Bryocaulon divergens*, this species differs in its smoother, less contorted, often paler branches, and its chemistry: inert to chloride bleach, while *B. divergens* gives a pink reaction in the interior of its stems and branches. *Bryocaulon hyperboreum* was recently named as a species new to science, and was previously reported only from Svalbard.

Bryoria nitidula (Th.Fr.) Brodo & D. Hawksw.	LICHEN
	Conservation Rank: S2S3; Blue listed.
	Habitat: Growing on mossy ground in alpine tundra, mostly on wind-blown ridgetops. Found in the Project area on rocky tundra in windy sites.
	From other *Bryoria* species that grow on the ground in alpine tundra in British Columbia, *B. nitidula* differs in its uniform, medium-brown colouration, its curved stems and branches with weakly developed spine-like side growths, lack of soredia, and its production of fumarprotocetraric acid (Goward 1999; Myllys et al. 2011). *Nodobryoria subdivergens* is similar, but has furrowed stems and branches and a different cellular structure. *Bryocaulon* spp. are also similar but are more distinctly red-brown and have protruding knobs on its stems. Photo from Nunavut.

Bryum calobryoides Spence	**MOSS**
	Conservation Rank: S1S2; Red listed.
	Habitat: Among other mosses in rocky sites, middle to high elevations.
	This species differs from other *Bryum* in having columnar-shaped leafy stems, concave leaves that are rounded to acute at the tip, a leaf mid-nerve that extends up most of the leaf, but not to the tip, short leaf cells, and uniformly green colour, without any reddish blush or bleached-looking portions (Spence 1986). Photo from light microscope, of specimen from the Project area.

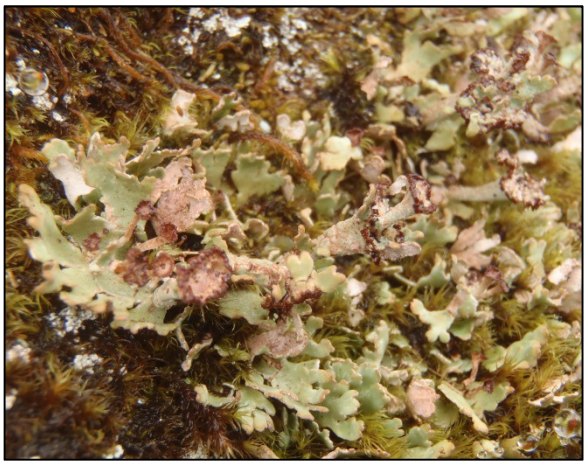
***Carex* sp. nov.**	**VASCULAR PLANT**
	Conservation Rank: Not ranked, previously undocumented in BC (see notes). Habitat: Rocky alpine tundra. The name *Carex atrata* was for many decades misapplied to similar species in western North America, but those species were eventually split off as species of their own, leaving no records of true *C. atrata* in British Columbia. The present plants are nearly identical to true *C. atrata,* except in their relatively short stature and darker-margined floral bracts (perigynial bracts). This new species is also geographically widely separated from true *C. atrata,* which in North America occurs only in Greenland.

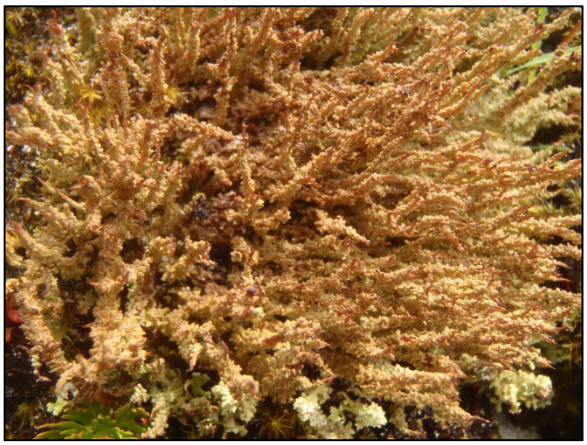
***Carex rostrata Stokes x utriculata* Boott**	**VASCULAR PLANT**
	Conservation Rank: S2S3; Blue listed (rank of *C. rostrata*). Habitat: Marshes and shores, low to middle elevations. When *Carex rostrata* and *C. utriculata* grow in proximity, they are often intermediate due to hybridization (Reznicek & Ford 2002). Only intermediates were found in the Project area, with stomates on both the upper and lower leaf surfaces (like *C. rostrata*), but with the sharply channelled leaf shape (like *C. utriculata*) and an intermediate leaf width. The only intermediates previously known between these two species are sterile hybrids that grow in proximity to the parental species, so it can be predicted that typical *C. rostrata* occurs in the Project area. The BC Conservation Data Centre tracks the intermediates along with characteristic populations of *C. rostrata* (J. Penny pers. comm. 2012). Photo from the Project area.

***Cetraria delisei* (Bory ex Schaerer) Nyl.**	**LICHEN**
	Conservation Rank: S3; Blue listed. Habitat: In alpine tundra, usually in low, wet spots. From other tundra-dwelling *Cetraria* sensu lato, *C. delisei* differs in its brown, non-glossy lobe surface, finely divided lobes that are flattened throughout, its production of gryophoric and hiascic acids, and its conspicuous white cortical thinnings, which are visible as stark white dots and dashes along the lobe margins (Goward et al. 1994). Photo from the Northwest Territories.

***Cetraria nigricans* Nyl.**	**LICHEN**
	Conservation Rank: S3; Blue listed. Habitat: On mossy ground in alpine tundra. This species is distinctive among ground-dwelling *Cetraria* by its blackish-brown, glossy lobe surface and lobe margins with numerous whip-like cilia, as well as its production of lichesterinic and protolichesterinic acids (Goward et al. 1994). It is unmistakable. Photo from the Project area.

Cladonia coccifera (L.) Willd.	LICHEN
	Conservation Rank: S1; Red listed.
	Habitat: Various open, usually rocky sites.
	This species was until the 1990's thought to be common and widespread in British Columbia, but it was found that almost all of those populations belong to the species *Cladonia borealis* instead (Stenroos 1989). *Cladonia coccifera* differs from that species in its abundant squamules (detachable, chip-like structures that serve as asexual reproductive structures) on the stems and its production of the compound zeorin. Photo from the Project area.

Cladonia pseudalcicornis Asahina	LICHEN
	Conservation Rank: S2S3; Blue listed.
	Habitat: On moist ground in alpine and subalpine heaths.
	This distinctive species is one of few *Cladonias* capable of producing basal squamules (leaf-like structures around the stem bases) as large as 10 mm long. It is also distinguished by having stems that form stacked tiers, in trumpet-shaped segments that proliferate new segments from the centre point of their termini (Ahti 2007). It is also distinctive in habitat, growing in moist heaths while its related species grow in drier, warmer sites. Photo from near the Project area.

***Cladonia singularis* S. Hammer**	**LICHEN**
	Conservation Rank: S2S3; Blue listed.
	Habitat: Various open sites, low to high elevations.
	Cladonia singularis is distinguished based on its dense, mound-forming growth, and its stems having a nearly complete covering of tiny squamules (chip-like structures attached at their bases, separating by their tips outward from the stem). This covering of squamules gives the stems a characteristic "candlestick" look, like candlesticks that have accumulated dripped candle wax. It is also distinguished by its production of squamatic acid (Goward 1999). Forms of *Cladonia squamosa* are very similar, but the stems of those species have squamules that flex back more strongly. Photo from the Project area.

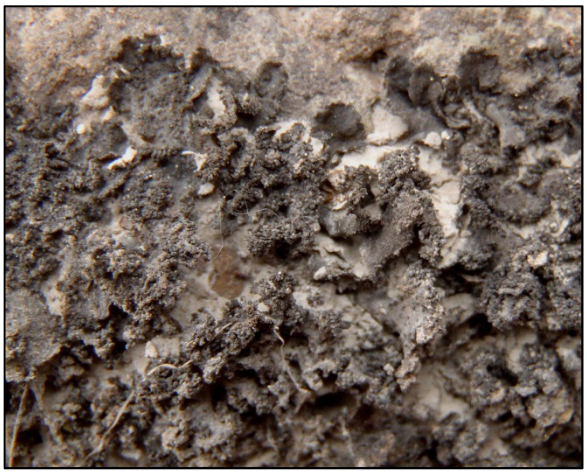
***Cladonia subfurcata* (Nyl.) Arnold**	**LICHEN**
	Conservation Rank: S2S3; Blue listed.
	Habitat: Various open, cool sites, low to middle elevations.
	This species is recognized by its short, thorn-like side branches and gaping holes at the branching points, but without holes at the stem tips. Additionally, it has a characteristic brown colour, and it produces squamatic acid (Goward 1999). Forms of *Cladonia crispata* can appear similar but differ in having gaping holes at the stem tips, not just at the branching points. Photo of specimen from Alaska.

Collema ceraniscum Nyl.	LICHEN
	Conservation Rank: S1; Red listed.
	Habitat: On high-pH soil over cliffs or on the ground; arctic-alpine. Observed in the Project area on seepy cliff ledges.
	From other *Collema* species, *C. ceraniscum* differs in having a jet-black colour, coralloid lobes that grow densely, forming a dense cushion, and small bowl-shaped apothecia. Species of the family Lichinaceae may appear similar, but these have simple spores, while those of *C. ceraniscum* are muriform (with multiple cells divided by longitudinal and transverse cross-walls; Goward et al. 1994; Jørgensen 2007a). Photo from Nunavut.

Collema crispum (Hudson) F. H. Wigg.	LICHEN
	Conservation Rank: S1; Red listed.
	Habitat: On soil and rock, in high-pH environments. Found in the Project area on cliffs at low elevations.
	From its closest lookalike *Collema* species, *C. crispum* differs in having chip-like rather than spherical or coral-formed isidia (asexual reproductive structures; Goward et al. 1994; Jørgensen 2007a). *Lempholemma polyanthes,* which grows in habitats similar to those of *C. crispum,* may sometimes appear similar. But when dry it has lobes and isidia of variable width, appearing in some parts inflated and in other parts deflated. Photo from south-central British Columbia.

Collema cristatum var. marginale (Huds.) Degel.	LICHEN
	Conservation Rank: S2S3; Blue listed. Habitat: On cliff of high-pH rocks. This species differs from other gelatinous lichens in its blackish or olive-brown colour, tightly attached and rosette-forming trough-shaped lobes with somewhat thickened margins, and presence of isidia (bead-like asexual reproductive structures) (Goward et al. 1994, Jørgensen 2007a). Photo from the Project area.

Collema glebulentum (Nyl. ex Crombie) Degel.	LICHEN
	Conservation Rank: S2S3; Blue listed. Habitat: On rock in cool, wet sites, especially along fast-flowing rivers, on seepy cliffs or in rocky tundra pools. This species is unique within *Collema* by its distinctive habitat (directly attached to periodically flooded or seepy rock faces), its black colour, and abundant isidia (bead-like to coralloid asexual reproductive structures; Goward et al. 1994; Jørgensen 2007a). Photo from Nunavut.

Collema sp. nov.	LICHEN
	Conservation Rank: Not ranked, a species new to science known only from the Project area.
	Habitat: On cobbles in a periodically flooded river back-channel.
	This species is somewhat similar to *Collema glebulentum* in habitat and basic appearance, but differs in having thicker lobes with distinctly thickened margins, and larger isidia (bead-like asexual reproductive structures). *Collema tenax* is similar in appearance, but that species never grows in wet sites (let alone periodically flooded), and does not grow directly attached to rock. *Collema sp. nov.* is known only from the Project area. Photo from the Project area.

Dermatocarpon leptophyllodes (Nyl.) Zahlbr. sensu lato	LICHEN
	Conservation Rank: S2S4; Blue listed.
	Habitat: On cliffs, low to middle elevations.
	Dermatocarpon leptophyllodes apparently represents a suite of species in western North America, including the non-characteristic form reported here, having relatively large squamules (short, chip-like lobes) with more ascending edges in contrast to the smaller, bun-like squamules of true *D. leptophyllodes* (Heiđmarsson 2000). The present form is otherwise known in few sites on Vancouver Island. All forms of *D. leptophyllodes* are currently tracked in British Columbia. Photo from the Project area.

Draba glabella Pursh	VASCULAR PLANT
	Conservation Rank: S2S3; Blue listed. Habitat: Open or lightly shaded sites on cliffs and rock outcrops, favouring high-pH soils. This species is distinguished by its leafy stems, toothed stem leaves, white flowers, mix of simple and branched hairs on the fruits, and the leaf hairs which are 4-8 branched (Al-Shehbaz et al. 2010). *Draba juvenilis* is similar, but its leaf hairs are cross-shaped, with four branches. Photo from the Project area.

Draba ruaxes Payson & H. St. John	VASCULAR PLANT
	Conservation Rank: S2S3; Blue listed. Habitat: Scree and rock outcrops on alpine peaks and ridges, probably always on high-pH rocks. This species differs from the similar species *Draba incerta* and *D. oligosperma* by the broader leaf shape, and leaf back surface with its branched hairs star-like rather than grill-like (i.e., hairs lacking side branches that stick out at 90° from the main branch). *Draba macounii* has mostly simple or few-branched hairs on its leaves (Al-Shehbaz et al. 2010). Photo from the Project area.

***Draba* sp. nov.**	**VASCULAR PLANT**
	Conservation Rank: Not ranked; a rare new species known only from the northern BC Coast Ranges.
	Habitat: Cliff crevices and ledges, in open or lightly shaded sites.
	This species is similar in some ways to *D. lonchocarpa*, but that species is a smaller plant, with greener and narrower leaves, and fruits narrower and straight, not twisted. The fruits are consistently twisted, often more than 360°, unlike any other species in British Columbia. It is also like *D. nivalis* in general appearance, but that species differs in having straight rather than twisted fruits, petals and sepals more quickly shed after flowering, and is generally a smaller plant. This new species is otherwise known only from nearby areas of the northern Coast Ranges. Photo from the Project area.

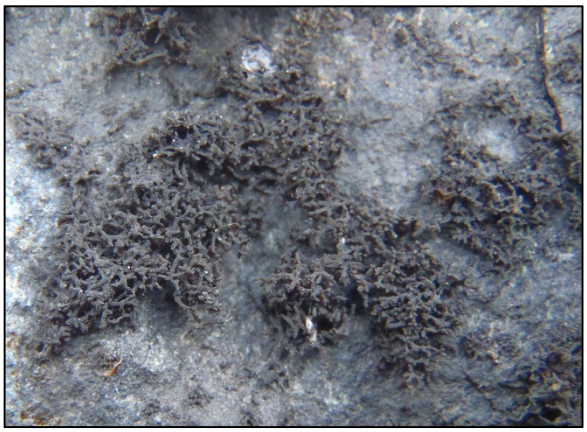
Epilobium davuricum Fisch. ex Hornem.	**VASCULAR PLANT**
	Conservation Rank: S1S3; Red listed.
	Habitat: Mossy ground, usually in and around wetlands; boreo-arctic.
	Epilobium davuricum differs from other *Epilobium* species in its growth form, with leaves clustered at the stem base, almost forming rosettes, and its numerous, paired stem leaves, as well as by its stem hairs, which are evenly distributed around the stem rather than arranged in vertical lines (Wagner & Hoch 2005). Photo from the Project area.

Epilobium hornemannii ssp. behringianum Rchb.	VASCULAR PLANT
	Conservation Rank: S2S3; Blue listed. Habitat: Moist ground, subalpine to alpine. This species is distinguished by its medium-sized stature, clumped stems, pink flowers, large stem leaves with few blunt teeth along the margins, and lower stem leaves that are persistent but shrivelled and dried by flowering time (Wagner & Hoch. 2005) (Photo from the Project area.

Epilobium leptocarpum Hausskn.	VASCULAR PLANT
	Conservation Rank: S2S3; Blue-listed. Habitat: Wet, mossy ground in and around high-elevation wetlands. This species is identified based on its erect stems with few, paired stem leaves, and fleshy, bulb like leaf clusters at the stem bases, as well as by its long, erect fruits on long stalks (Wagner & Hoch 2005). It is distinguishable by its long, erect fruits held well above the leaves, and by its habitat. Photo from the Project area.

Fuscopannaria cheiroloba (Müll. Arg.) P.M. Jørg.	LICHEN
	Conservation Rank: A rare species known from very few populations in its rather limited range.
	Habitat: Over mosses on cliffs and soil banks, in light shade or full sun.
	This species is unique within the genus by its thick, convex, matte lobes, lack of soredia or isidia (dust-like or bead-like asexual reproductive structures), its light olive brown colour, its dense patch-forming growth, and its moderately elongated peripheral lobes (Jørgensen 2000). Photo from the Project area

Helodium paludosum (F. Weber & D. Mohr) Warnst.	MOSS
	Conservation Rank: Not ranked, but otherwise known in BC from only two localities.
	Habitat: In marshes and fens, over moderate- to high-pH soil.
	From the much more common *Helodium blandowii, H. paludosum* differs in having a central strand (column of small, compact cells running up the middle of the stem, paraphyllia (detatchable structures that allow asexual reproduction) scattered and short, stem leaves relatively green and long-tapered to the tip, and a distinctive pale, glassy region of the leaf base near its attachment to the stem (Eckel 2012). Photo from the Project area.

Lempholemma intricatum (Arnold) Zahlbr.	LICHEN
	Conservation Rank: S1S2; Red listed. Habitat: Seepy cliffs and river-side rocks. This small, gelatinous lichen is distinguished based on its multiply branched, bushy growth, 1-celled spores, poorly developed cortex (surface "skin"), and the presence of the cyanobacterium Nostoc as the photosynthetic partner in the lichen symbiosis (Jørgensen 2007b). Photo from the Northwest Territories.

Leptogium cyanescens (Rabenh.) Körb.	LICHEN
	Conservation Rank: S1; Red-listed. Habitat: On rocks in cool, humid sites. This species differs from other *Leptogium* species by its bluish colour, broad and fan-shaped lobe tips that are at least in part lined with paddle-shaped isidia (asexual reproductive structures; Goward et al. 1994; Jørgensen 2007a). *Collema glebulentum* can appear similar and grows in like habitats, but like all *Collema* species, it differs from *L. cyanescens* in having a thick gel layer rather than a cell layer at the lobe surface. Photo from the Project area.

Leptogium imbricatum P. M. Jørg.	LICHEN
	Conservation Rank: Not ranked, previously undocumented in British Columbia (previous reports from BC have proven incorrect).
	Habitat: Over mosses or on soil in high-pH habitats; boreo-arctic. Found in the Project area on ledges of seepy cliffs.
	From all other *Leptogium* species in North America, *L. imbricatum* differs in having minute lobes that tend to overlap like shingles on a roof (Jørgensen 2007a). *Leptogium gelatinosum* may sometimes produce this shingle-like growth form, but that species is relatively reddish brown, glossier, and with at least a few of its lobes having raised ridges crossing over the lobe upper surface. Photo from Nunavut.

Micranthes nelsoniana var. nov.	VASCULAR PLANT
	Conservation Rank: Not ranked, a rare plant new to science.
	Habitat: On moist, mossy ground in open or lightly shaded sites, middle to subalpine elevations.
	Among the varieties of *M. nelsoniana,* this undescribed form differs in having its stem hairs tipped in spherical, purple glands, and by the low number of teeth along the leaf margin. Only one other variety has purple-tipped glands, ssp. *nelsoniana,* which grows only in the arctic well to the north of the present subspecies, and that species also differs in having more leaf teeth (15-21), shorter flower stalks, and fruit halves fused along most of their length. The new variety is otherwise known only from a cluster of populations further south in the BC Coast Ranges. Photo from the Project area.

***Miehlichhoferia elongata* (Hoppe & Hornsch.) Nees & Hornsch.**	**MOSS**
	Conservation Rank: Not ranked, but the present population is apparently the only one documented thus far from British Columbia; said in literature to be globally rare, though this is not reflected by the perhaps erroneous Natureserve rank of G4 (Natureserve 2012). Habitat: Cool, humid sites, on extremely acidic rocks rich in iron. This species is easily identified by its habit of covering large areas in astroturf-like lawns on metal-rich rocks in cool, humid habitats. *Mielichhoferia mielichhoferiana* also grows on metal-rich rocks, but tends to form small patches, and also differs in its darker colour and lack of shimmery irridescence, and its thicker walled cells in the terminal portion of the leaf (Shaw 2009). Photo from the project area.

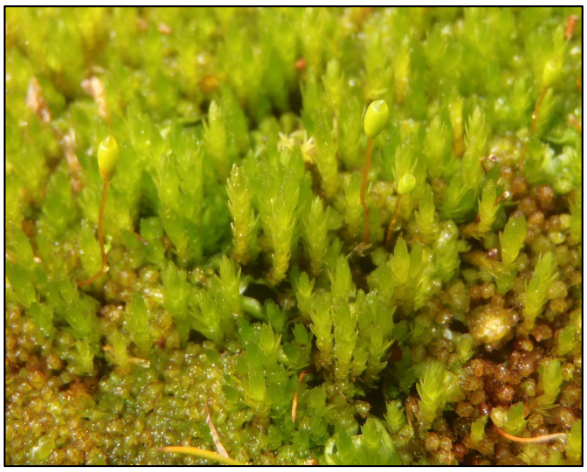
***Nodobryoria subdivergens* (E. Dahl) Common & Brodo**	**LICHEN**
	Conservation Rank: S2S3; Blue-listed. Habitat: Rocky tundra on wind-blown ridgetops. *Nodobryoria* is easily confused with *Bryoria* and *Bryocaulon,* differing from them most distinctly in the outermost layer of its stems and branches, formed of cells that resemble jigsaw puzzle pieces; the surficial cells of *Bryoria* and *Bryocaulon* are blocky, without sinuous edges. *Nodobryoria oregana,* like *N. subdivergens* sometimes grows on the ground in alpine tundra, but that species has thicker and smooth, not furrowed stems and branches, and ground dwelling populations of that species tend to occur near treeline (Goward 1999; Goward pers. comm. 2012). Photo from the Project area.

***Parmelia skultii* Hale**	**LICHEN**
	Conservation Rank: S1; Red listed.
	Habitat: Tundra, especially at cliff bases or around bird-perch rocks.
	This species differs from other *Parmelia* species in its lack of soredia and isidia (dust-like or bead-like asexual reproductive structures), its silvery colour, short, blocky lobes, and its preference for growing on the ground in open tundra (Thell & Moberg 2011). Photo from Nunavut.

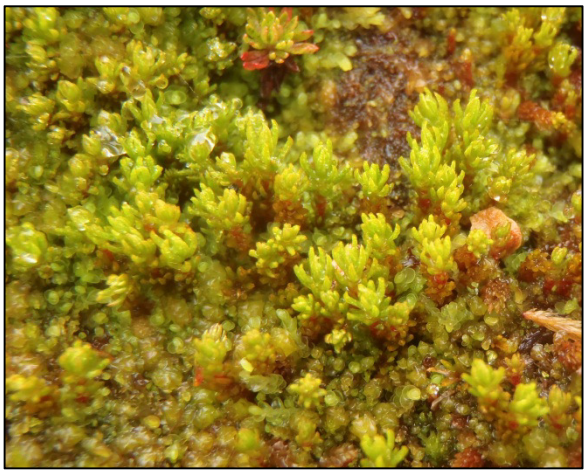
***Phaeophyscia cf. nigricans* (Flörke) Moberg**	**LICHEN**
	Conservation Rank: *Phaeophyscia nigricans* is ranked S1, Red-listed, but the population in the Project area may not belong under that species.
	Habitat: On cliff face in alpine tundra.
	This peculiar lichen has no known parallels in alpine environments in British Columbia. Its small size, dark brown colour, production of apothecia rather than any asexual reproductive structures, and its protruding rhizines (root like structures on the lobe lower surface) collectively make this species unique. *Phaeophyscia nigricans* is a similarly small sized, low-elevation species that differs in having inconspicuous, non-protruding rhizines, asexual reproduction, and a paler lower surface. *Phaeophyscia decolor* is similar in being small and having apothecia, but that species has inconspicuous rhizines, a somewhat larger size, paler colour, thicker lobes, and grows at low elevations (Goward et al. 1994). Photo from the Project area.

Placynthium asperellum (Ach.) Trevis.	LICHEN
	Conservation Rank: S3?; Blue-listed. Habitat: On periodically wet rocks, arctic-alpine. This species differs from other *Placynthium* in lacking a conspicuous blue-black margin around the thallus, narrow thallus lobes that are weakly elongated around the thallus margin, coral-like isidia (asexual reproductive structures), blackish colour and greater gloss (Jørgensen 2007d) Photo from Nunavut.

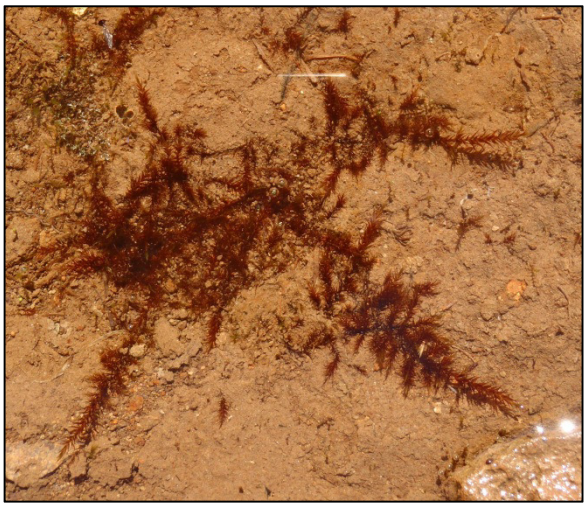
Plagiobryum demissum (Hook.) Lindb.	MOSS
	Conservation Rank: S1S2; Red-listed. Habitat: On small pockets of high-pH soil on cliffs and rock outcrops in cool, humid climates. *Plagiobryum* is easily recognized by its spore capsules, which are held at more or less a horizontal angle, and which are large, club shaped and gradually narrowed along a sterile portion to the base. From *P. zierii, P. demissum* differs in brownish green foliage, lack of worm-like leafy stems, narrower leaves that are down-curved along the margins, and spores remaining stuck together in bundles of four (Spence 2007). Photo of specimen southern British Columbia.

Pohlia cardotii (Renauld) Broth.	MOSS
	Conservation Rank: S2; Red-listed. Habitat: Moist, mossy ground, subalpine to alpine elevations. This species is easily identified by its partly down-curved leaf margins (all other North American *Pohlia* except *P. crudoides* have flat leaf margins). From *P. crudoides* it differs in having shorter leaves, a thicker costa that broadens greatly downward to the leaf base, and erect capsules (Shaw 2009). Photo from the Project area.

Polemonium elegans E. Greene	VASCULAR PLANT
	Conservation Rank: S2S3; Blue-listed. Habitat: Alpine ridgetops, favouring high-pH soils. *Polemonium elegans* differs from other species of the genus in British Columbia by its low stature, densely-spaced but not whorled, blunt-tipped, sticky leaflets, and its tight cluster of large flowers. *Polemonium boreale* is similar, but has more loosely-spaced, more pointed-tipped leaflets and is not particularly sticky. *Polemonium pulcherrimum* has smaller flowers and grows more erect. *Polemonium viscosum* has leaflets in whorls of four. Photo from the Project area.

***Psilopilum cavifolium* (Wilson) I. Hagen**	**MOSS**
	Conservation Rank: S1S2; Red-listed. Habitat: On moist, mossy ground, subalpine to alpine, usually in tundra. *Psilopilum* is a highly distinctive genus, with its firm, leathery leaves that curve over the back, its few lamellae (flaps that run the length of the leaf on the inner surface), and smooth rather than angled capsules. *Psilopilum laevigatum* differs in its shorter capsules and its more strictly erect leaves (Smith-Merrill 2007). Photo from the Project area.

***Ranunculus occidentalis ssp. hexasepalus* L.D. Benson**	**VASCULAR PLANT**
	Conservation Rank: S1S3; Red-listed. Habitat: Wet ground in herbaceous communities, sea level to alpine. This subspecies is defined primarily on the supernumerary petals (more than 5 per flower; Whittemore 1997). That distinction is not actually defining since it appears sporadically in populations of the other subspecies and not consistently in ssp. *hexasepalus*. Instead, the subspecies is better defined by its larger stature, thicker stems, less deeply lobed leaves, leafier stems and large petals. Photo from the Project area. Subspecies *hexasepalus* was previously known only from Haida Gwaii at low elevations. Additional occurrences from higher elevations have since been documented. The present population is now known also from the mainland.

Sarmentypnum pseudosarmentosum (Cardot & Thériot) Hedenäs	MOSS
	Conservation Rank: Not ranked; previously undocumented in British Columbia. Habitat: In shallow pools in tundra, arctic-alpine. This distinctive species is characterized by its red-brown colour, straight and long-tapered leaves with the midvein fading before the leaf tip, the inflated cells in the corners of the leaf attachment, and the higher-pH habitats it prefers (Hedenäs 2008). In specimen review of this and similar species in the bryophyte collection at UBC, no additional BC specimens were found. Photo from the Project area.

Solorina bispora Nyl.	LICHEN
	Conservation Rank: S2S3; Blue-listed. Habitat: On high-pH soil, usually on seepages on cliff ledges. This species is identified by its often broadly expanded, leafy growth, solitary or few-clustered apothecia (spore-bearing structures that appear as dark depressions), and its production of pairs of large spores, rather than 4 to 8 smaller spores, in its asci (microscopic sack-like structures that produce the spore broods; Goward et al. 1994). Photo from Nunavut.

Solorina octospora (Arnold) Arnold	LICHEN
	Conservation Rank: S3; Blue-listed. Habitat: On high-pH soil, especially on seepages on cliff ledges. *Solorina octospora* is distinctive in having a broadly leafy growth form and apothecia (spore bearing structures that appear as dark depressions on the thallus surface) clustered, often numerous so. Also, it produces eight spores per ascus (microscopic sack-like structure that produces broods of spores; Goward et al. 1994). Photo from the Project area.

Sphaerophorus fragilis (L.) Pers.	LICHEN
	Conservation Rank: S2S3; Blue-listed. Habitat: On rock in tundra. This species differs from other *Sphaerophorus* by its very dense, cushion-like growth, more equal branching (i.e., branching that results in two equal forks rather than one thick and one thin), and its negative reaction to iodine when applied to the stem interior. Most similar is *Sphaerophorus globosus,* which reacts dark violet-blue to iodine, has unequal branches and main, dominant stems, and a usually pretzel-brown colour (Goward 1999). Photo from the Project area.

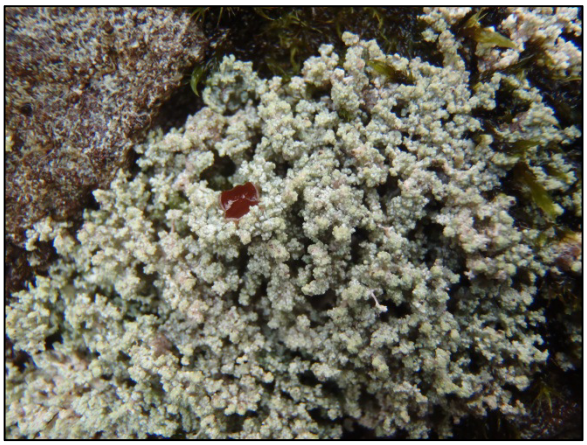
***Sphagnum annulatum* Warnst.**	**MOSS**
	Conservation Rank: S1S2; Red-listed.
	Habitat: In fens, where poor to moderate in mineral nutrients.
	From other members of Sphagnum section *Cuspidata, S. annulatum* differs in having the convex surface of its branch leaf hyaline cells (i.e., water storing cells that have no chlorophyll) ornamented with two rows of numerous small pores that do not about the cell edge where it meets the chlorophyll-bearing cells. In appearance, this species characteristically has a brownish colour, small capitulum (head of young, developing branches), and somewhat curved branches (Andrus & McQueen 2007; Laine et al. 2009). Photo from the Project area.

***Sphagnum aongstroemii* C. Hartm.**	**MOSS**
	Conservation Rank: S2S3; Blue-listed.
	Habitat: Moist rocky ground and cliff bases, usually over higher-pH soils.
	This species is easily recognized based on its deeply concave, broadly egg-shaped branch leaves that have an especially broad, prominently toothed tip, the lack of spiral reinforcing fibrils in the outer stem cells, and its small capitulum (head-like cluster of young, developing branches) with a prominent central bud. Additionally, its plump appearance and pale green colour are diagnostic (Laine et al. 2009). Photo from the Project area.

***Stereocaulon botryosum* Ach.**	**LICHEN**
	Conservation Rank: S2; Red-listed. Habitat: On rock surfaces in cool, humid sites. This species is recognized by its habitat, growing directly on rock surfaces, its chemical constituents of atranorin and porphyrilic acid, and its small phyllocladia (thalline units that are analogous to the leaves on a tree), so small as to resemble soredia. Additionally, it has the cyanobacterium *Nostoc* in its cephalodia (most of the thallus is made of a fungus-alga symbiosis, except the scattered brown, lumpy cephalodia that contain the *Nostoc* cells; Goward 1999). Photo from the Project area.

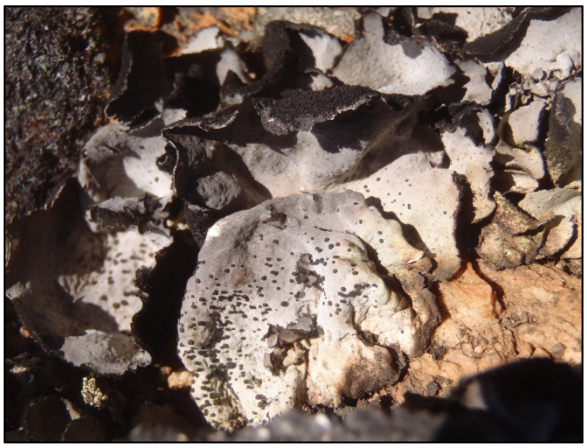
***Stereocaulon depressum* (Frey) I.M. Lamb**	**LICHEN**
	Conservation Rank: S1; Red-listed. Habitat: On rock faces, cliffs and outcrops at high elevations. This species is recognized by its habitat (growing directly on rock faces), its production of atranorin and bourgeanic acid, its small size with branches spreading out at low angles rather than growing erect, and its phyllocladia (thalline units analogous to the leaves on a tree) flattened and notched, not coral-like (Goward 1999). This species is known in BC from only one other collection. Photo from the Project area.

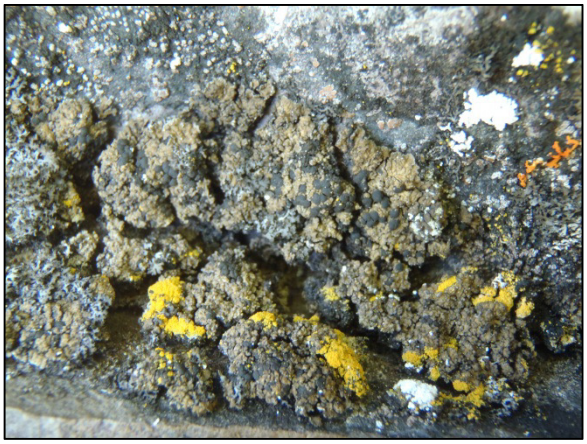
Stereocaulon glareosum (Savicz) H. Magn.	LICHEN
	Conservation Rank: S2S3; Blue-listed. Habitat: On soil in tundra. Among Stereocaulon species, S. glareosum is distinct in its sombre grey colour, broadly spreading thalli, short stature, its sandy-ground habitat, and in having Nostoc in its cephalodia (cephalodia are scattered dark masses containing cyanobacteria, while the rest of the thallus lacks cyanobacteria but has algae instead as the photosynthetic photobiont). It is also identified by its chemical constituents: atranorin, often also with lobaric acid (Goward 1999). Photo from the Northwest Territories.

Stereocaulon symphycheilum I.M. Lamb	LICHEN
	Conservation Rank: S1S2; Red-listed. Habitat: On rock surfaces, upper montane to alpine. This species is easily identified based on its having soredia (easily detachable, dust-like asexual reproductive structures) and its phyllocladia (thalline units that function like the leaves on a tree) evenly distributed around the stems and two-toned, with a green centre and whitish perifery. Additionally, it is distinguished by its production of the substances atranorin and lobaric acid (Goward 1999). Photo from the southern BC Coast Ranges.

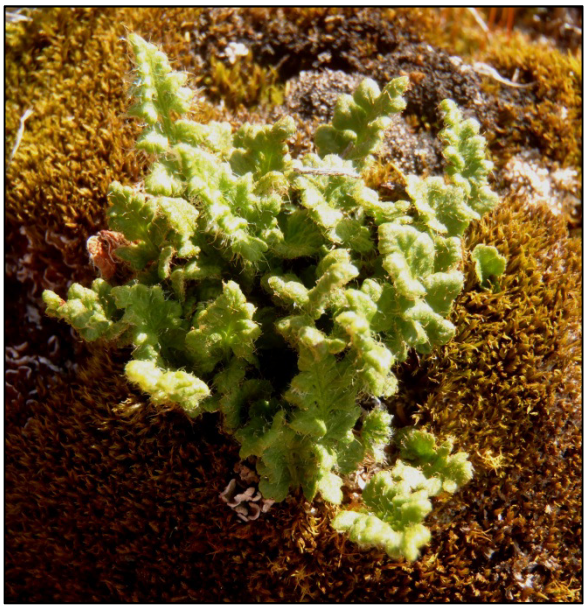
Tomentypnum falcifolium (Nichols) Tuom.	MOSS
	Conservation Rank: S3; Blue-listed. Habitat: In fens with a somewhat elevated pH. From *Tomentypnum nitens*, this species differs in its curved leaves, which point all in the same direction in orientation to the stem, its leaf shape (widest shortly above the base rather than directly at the base), and in its rhizoids (felty masses of root-like structures) growing only from the leaf bases, not from the stems. (Flaubert 2004). Photo from central British Columbia.

Umbilicaria lambii Imshaug	LICHEN
	Conservation Rank: S3; Blue-listed. Habitat: On acidic rock surfaces, alpine, on wind-blown ridgetops. This unmistakable species is highly distinctive from other *Umbilicaria* in its small size and tight attachment to rock surfaces. All other species of the genus produce large, saucer-shaped growth with a single, central, umbilicus-like attachment point (Llano 1954). Photo from the Project area.

Umbilicaria sp. nov.	LICHEN
	Conservation Rank: Not listed, a new species known only from the Project area.
	Habitat: On rock pinnacles in alpine tundra.
	This peculiar species is unique among species of *Umbilicaria* in the combination of its white-dusted upper surface, brown lower surface with bundled black rhizines (root-like structures), and abundant apothecia. *Umbilicaria virginis* is similar, but has simple, smooth apothecia, while the new species has its apothecia tightly folded, with furrows appearing finger-print like. *Umbilicaria cylindrica* is also similar, but is smaller and has its rhizines more evenly dispersed, not bundled, and the thallus margins are fringed with rhizines.

Vahliella leucophaea (Vahl) P.M. Jørg.	LICHEN
	Conservation Rank: Previously undocumented in BC.
	Habitat: On rock, usually on slight seepage sites or on dust-impregnated underhangs.
	This species is similar to *Vahliella californica,* differing in spore size, usually paler colour, and in its slightly more distinctly lobed thallus perimeter (Jørgensen 2007d; Goward pers. comm. 2012). It is found primarily in eastern North America and Europe. It was recently discovered in western North America with the find of a small number of populations in British Columbia and Montana. Photo from the Project area.

***Vestergrenopsis elaeina* (Wahlenb.) Gyeln.**	**LICHEN**
	Conservation Rank: S2S3; Blue-listed. Habitat: On rock surfaces in constantly cool, humid habitats. No other lichen in British Columbia is likely to be confused with *V. elaeina*. The combination of a cyanobacterial photosynthetic symbiotic partner, lobed, rosette forming growth, brown colour and production of numerous apothecia mark it as highly distinct (Goward et al. 1994). Photo from the Project area.

***Woodsia alpina* (Bolton) A. Gray**	**VASCULAR PLANT**
	Conservation Rank: S2S3; Blue-listed. Habitat: On ledges and in crevices of cliffs and rock outcrops, arctic-alpine. This species is intermediate in characteristics between *Woodsia glabella* and *W. ilvensis,* both of which are more common in British Columbia and beyond. Like *W. glabella,* it has relatively simple leaves, with the primary lobes only few-notched rather than with secondary lobes. Similar to *W. ilvensis* and in contrast to *W. glabella,* it has abundant hairs over the leaf surfaces and along the leaf stalk (Lellinger 1985). Photo from the Project area.

Appendix 8-2

Nomenclatural List of all Plant and Lichen Species Observed in the LSA

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Appendix 8-2. Nomenclatural List of all Plant and Lichen Species Observed in the LSA

LICHENS

Acarospora glaucocarpa (Ach.) Körber
Acarospora sinopica (Wahlenb.) Körber
Acarospora smaragdula (Wahlenb.) A. Massal.
Agyrium rufum (Pers.) Fr.
Alectoria ochroleuca (Hoffm.) A. Massal.
Alectoria sarmentosa (Ach.) Ach. ssp. *sarmentosa*
Allantoparmelia almquistii (Vainio) Essl.
Allantoparmelia alpicola (Th. Fr.) Essl.
Amygdalaria consentiens (Nyl.) Hertel, Brodo & Mas. Inoue
Amygdalaria panaeola (Ach.) Hertel & Brodo
Arctoparmelia incurva (Pers.) Hale
Arthrorhaphis alpina (Schaerer) R. Sant.
Arthrorhaphis citrinella (Ach.) Poelt
Aspicilia (unknown, brown hypothecium)
Aspicilia aquatica Körber
Aspicilia bullate unknown species
Aspicilia cf. *laevata* (Ach.) Arnold.
Aspicilia chalky unknown species
Aspicilia contorta (Hoffm.) Kremp.
Aspicilia gray aquatic unknown species
Aspicilia rimmed aquatic unknown species
Aspicilia verrucosa (Ach.) Körb.
Bacidina sp. A of Spribille et al.
Baeomyces carneus Flörke
Baeomyces rufus (Hudson) Rebent.
Bellemerea alpina (Sommerf.) Clauzade & Cl. Roux
Bellemerea cinereorufescens (Ach.) Clauzade & Cl. Roux
Bellemerea sanguinea (Kremp.) Hafellner & Cl. Roux
Bellemerea subsorediza (Lynge) R. Sant.
Belonia russula Körber ex Nyl.
Biatora cuprea (Sommerf.) Fr.
Biatora flavopunctata (Tønsberg) Hinteregger & Printzen
Biatora meiocarpa (Nyl.) Arnold
Biatora oligocarpa Printzen & Tønsberg
Biatora subduplex (Nyl.) Printzen
Biatora toensbergii Holien & Printzen
Biatora vacciniicola (Tønsberg) Printzen
Bilimbia accedens Arnold
Bilimbia sabuletorum (Schreber) Arnold
Brodoa oroarctica (Krog) Goward
Bryocaulon divergens (Ach.) Kärnefelt
Bryocaulon hyperboreum Øvstedal
Bryonora pruinosa (Th. Fr.) Holtan-Hartwig
Bryoria fremontii (Tuck.) Brodo & D. Hawksw.
Bryoria fuscescens (Gyelnik) Brodo & D. Hawksw.
Bryoria glabra (Motyka) Brodo & D. Hawksw.
Bryoria kockiana Goward ined.
Bryoria nitidula (Th. Fr.) Brodo & D. Hawksw.
Bryoria tenuis (E. Dahl) Brodo & D. Hawksw.
Bryoria trichodes ssp. *americana* (Motyka) Brodo & D. Hawksw.
Buellia penichra (Tuck.) Hasse
Calicium viride Pers.
Caloplaca arenaria (Pers.) Müll. Arg.
Caloplaca exsecuta (Nyl.) Dalla Torre & Sarnth.
Caloplaca holocarpa (Hoffm. ex Ach.) A. E. Wade
Caloplaca jungermanniae (Vahl) Th. Fr.
Caloplaca nivalis (Körber) Th. Fr.
Caloplaca sorocarpa (Vainio) Zahlbr.
Candelariella efflorescens R.C. Harris & W.R. Buck
Candelariella rosulans (Müll. Arg.) Zahlbr.
Candelariella vitellina (Hoffm.) Müll. Arg.
Catapyrenium cinereum (Pers.) Körber
Catapyrenium daedaleum (Kremp.) Stein
Catillaria sp. unknown

Cetraria delisei (Bory ex Schaerer) Nyl.
Cetraria ericetorum Opiz ssp. *ericetorum*
Cetraria islandica (L.) Ach. ssp. *islandica*
Cetraria islandica ssp. *crispiformis* (Räsänen) Kärnefelt
Cetraria nigricans Nyl.
Cetraria subalpina Imshaug
Cladina (unknown) KC+ yellow, K+ yellow
Cladina arbuscula (Wallr.) Hale & W. L. Culb.
Cladina cf. rangiferina (L.) Nyl. (branching too consistently in twos)
Cladina mitis (Sandst.) Mong.
Cladina rangiferina (L.) Nyl.
Cladina stellaris (Opiz) Brodo
Cladina stygia (Fr.) Ahti
Cladonia amaurocraea (Flörke) Schaerer
Cladonia bellidiflora (Ach.) Schaerer
Cladonia borealis S. Stenroos
Cladonia cariosa (Ach.) Sprengel
Cladonia carneola (Fr.) Fr.
Cladonia cenotea (Ach.) Schaerer
Cladonia cervicornis (Ach.) Flotow ssp. *cervicornis*
Cladonia cf. *bellidiflora* (Ach.) Schaerer (cups too broad)
Cladonia cf. *macrophyllodes* Nyl. (but squamules too short and strap-shaped)
Cladonia cf. *maxima* (Asahina) Ahti
Cladonia cf. *pyxidata* (L.) Hoffm. (narrow revolute squamules
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel
Cladonia coccifera (L.) Willd.
Cladonia coniocraea (Flörke) Sprengel
Cladonia cornuta (L.) Hoffm. ssp. *cornuta*
Cladonia cornuta ssp. *groenlandica* (E. Dahl) Ahti
Cladonia crispata ssp. *crispata* (Ach.) Flotow
Cladonia crispata var. *cetrariiformis* (Delise) Vainio
Cladonia cyanipes (Sommerf.) Nyl.
Cladonia deformis (L.) Hoffm.
Cladonia digitata (L.) Hoffm.
Cladonia ecmocyna ssp. *intermedia* (Robbins) Ahti
Cladonia ecmocyna ssp. *occidentalis* Ahti
Cladonia fimbriata (L.) Fr.
Cladonia furcata (Hudson) Schrader
Cladonia gracilis ssp. *elongata* (Jacq.) Vainio
Cladonia gracilis ssp. *turbinata* (Ach.) Ahti
Cladonia gracilis ssp. *vulnerata* Ahti
Cladonia kanewskii Oxner
Cladonia macilenta Hoffm.
Cladonia macroceras (Delise) Hav. ?
Cladonia macrophylla (Schaerer) Stenh.
Cladonia macrophyllodes Nyl.
Cladonia merochlorophaea Asahina
Cladonia metacorallifera Asahina
Cladonia ochrochlora Flörke
Cladonia pleurota (Flörke) Schaerer
Cladonia pocillum (Ach.) Grognot
Cladonia pseudalcicornis Asahina
Cladonia pyxidata (L.) Hoffm.
Cladonia rangiformis Hoffm.
Cladonia singularis S. Hammer
Cladonia sp. 1 sensu Goward 1999
Cladonia squamosa Hoffm.
Cladonia stricta (Nyl.) Nyl.
Cladonia subfurcata (Nyl.) Arnold
Cladonia sulphurina (Michaux) Fr.
Cladonia symphycarpia (Flörke) Fr.
Cladonia transcendens (Vainio) Vainio
Cladonia umbricola Tønsberg & Ahti
Cladonia uncialis (L.) F. H. Wigg.
Cladonia wainioi Savicz
Coelocaulon aculeatum (Schreber) Link
Coelocaulon muricatum (Ach.) J. R. Laundon
Coelocaulon sp. nov.
Collema callopismum var. *callopismum* A. Massal.
Collema ceraniscum Nyl.
Collema crispum (Hudson) F. H. Wigg.
Collema cristatum var. *marginale* (Hudson) Degel.
Collema curtisporum Degel.
Collema fuscovirens (With.) J. R. Laundon
Collema glebulentum (Nyl. ex Crombie) Degel.
Collema sp. nov.
Collema subflaccidum Degel.
Collema undulatum Laurer ex Flotow
Cryptothele Th. Fr. sp.
Cyphelium inquinans (Sm.) Trevisan
Dactylina arctica (Richardson) Nyl.

Dactylina ramulosa (Hooker) Tuck.
Dermatocarpon bachmannii Anders
Dermatocarpon intestiniforme (Körber) Hasse
Dermatocarpon leptophyllodes (Nyl.) Zahlbr. sensu lato
Dermatocarpon reticulatum H. Magn.
Dermatocarpon rivulorum (Arnold) Dalla Torre & Sarnth.
Dibaeis baeomyces (L. f.) Rambold & Hertel ? (sterile crust only, not reproductive, cannot be identified with confidence)
Diploschistes scruposus (Schreber) Norman
Ephebe hispidula (Ach.) Horw.
Ephebe sp. nov.
Epilichen scabrosus (Ach.) Clem.
Euopsis granatina (Sommerf.) Nyl.
Euopsis pulvinata (Schaerer) Nyl.
Flavocetraria cucullata (Bellardi) Kärnefelt & Thell
Flavocetraria nivalis (L.) Kärnefelt & Thell
Frutidella caesioatra (Schaerer) Kalb
Frutidella pullata (Norman) Schmull
Fuscopannaria cheiroloba (Müll. Arg.) P. M. Jørg.
Fuscopannaria mediterranea (Tav.) P. M. Jørg.
Fuscopannaria praetermissa (Nyl.) P. M. Jørg.
Gowardia nigricans (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen
Haematomma ochroleucum (Necker) J. R. Laundon
Hypogymnia apinnata Goward & McCune
Hypogymnia austerodes (Nyl.) Räsänen
Hypogymnia dichroma Goward
Hypogymnia enteromorpha (Ach.) Nyl.
Hypogymnia inactiva (Krog) Ohlsson
Hypogymnia occidentalis L. Pike
Hypogymnia rugosa (G. Merr.) L. Pike
Hypogymnia wilfiana Goward, T. Sprib. & Ahti
Icmadophila ericetorum (L.) Zahlbr.
Imshaugia aleurites (Ach.) S. F. Meyer
Ionaspis lacustris (With.) Lutzoni
Ionaspis odora (Ach.) Th. Fr. ex Stein
Japewia subaurifera Muhr & Tønsberg
Japewia tornoensis (Nyl.) Tønsberg
Kaernefeltia merrillii (Du Rietz) Thell & Goward
Koerberiella wimmeriana (Körber) Stein
Lecanora argopholis (Ach.) Ach.
Lecanora bicincta Ramond
Lecanora cadubriae (A. Massal.) Hedl.
Lecanora caesiosora Poelt
Lecanora cenisia Ach.
Lecanora chlarotera Nyl. s. lat.
Lecanora epanora (Ach.) Ach.
Lecanora epibryon (Ach.) Ach.
Lecanora frustulosa (Dickson) Ach.
Lecanora fuscescens (Sommerf.) Nyl.
Lecanora marginalis (Schaerer) Hertel & Rambold
Lecanora muralis (Schreber) Rabenh.
Lecanora polytropa (Hoffm.) Rabenh.
Lecanora pulicaris (Pers.) Ach.
Lecanora reagens Norman
Lecanora rupicola (L.) Zahlbr.
Lecanora stenotropa Nyl.
Lecidea albohyalina (Nyl.) Th. Fr.
Lecidea alpestris Sommerf. (sensu Thomson)
Lecidea auriculata Th. Fr.
Lecidea berengeriana (A. Massal.) Nyl. group
Lecidea betulicola (Kullh.) H. Magn.
Lecidea erythrophaea Flörke ex Sommerf.
Lecidea fuscatoatra Nyl. group
Lecidea hypnorum Lib.
Lecidea laboriosa Müll. Arg.
Lecidea lapicida (Ach.) Ach.
Lecidea porphyrospoda (Anzi) Th. Fr.
Lecidella wulfenii (Hepp) Körber
Lecidoma demissum (Rutstr.) Gotth. Schneider & Hertel
Leciophysma furfurascens (Nyl.) Gyelnik ? (but with Scytonema)
Lempholemma cladodes (Tuck.) Zahlbr.
Lempholemma intricatum (Arnold) Zahlbr.
Lempholemma polyanthes (Bernh.) Malme
Lepraria alpina (B. de Lesd.) Tretiach & Baruffo
Lepraria incana (L.) Ach.
Lepraria membranacea (Dickson) Vainio
Lepraria vouauxii (Hue) R. C. Harris
Leptogium cyanescens (Rabenh.) Körber
Leptogium gelatinosum (With.) J. R. Laundon
Leptogium imbricatum P. M. Jørg.

Leptogium intermedium (Arnold) Arnold (epiphytic form)
Leptogium plicatile (Ach.) Leighton group
Leptogium pulvinatum (Hoffm.) Otálora
Leptogium saturninum (Dickson) Nyl.
Leptogium teretiusculum (Wallr.) Arnold
Lichinodium sirosiphoideum Nyl.
Lobaria hallii (Tuck.) Zahlbr.
Lobaria linita (Ach.) Rabenh.
Lobaria oregana (Tuck.) Müll.
Lobaria pulmonaria (L.) Hoffm.
Lobaria scrobiculata (Scop.) DC.
Lopadium pezizoideum (Ach.) Körber
Massalongia carnosa (Dickson) Körber
Melanelia hepatizon (Ach.) Thell
Melanelia sorediata (Ach.) Goward & Ahti
Melanelia stygia (L.) Essl.
Melanohalea septentrionalis (Lynge) O. Blanco et al.
Micarea tenebrosa Björk ined.
Micarea turfosa (A. Massal.) Du Rietz
Moelleropsis nebulosa (Hoffm.) Gyeln.
Montanelia sorediata (Ach.) Divakar, A. Crespo, Wedin & Essl.
Mycobilimbia epixanthoides (Nyl.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen
Mycobilimbia tetramera (De Not.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen ex Hafellner & Türk
Mycoblastus affinis (Schaerer) T. Schauer
Mycoblastus sanguinarius (L.) Norman
Mycocalicium subtile (Pers.) Szatala
Myochroidea leprosula (Arnold) Printzen, T. Sprib. & Tønsberg
Myochroidea rufofusca (Anzi) Printzen, T. Sprib. & Tønsberg
Nephroma arcticum (L.) Torss.
Nephroma bellum (Sprengel) Tuck.
Nephroma expallidum (Nyl.) Nyl.
Nephroma helveticum ssp. *sipeanum* (Gyelnik) Goward & Ahti
Nephroma parile (Ach.) Ach.
Nodobryoria subdivergens (E. Dahl) Common & Brodo
Ochrolechia bryophaga (Erichsen) K. Schmitz & Lumbsch
Ochrolechia frigida (Sw.) Lynge
Ochrolechia grimmiae Lynge
Ochrolechia gyalectina (Nyl.) Zahlbr.
Ochrolechia inaequatula (Nyl.) Zahlbr.
Ochrolechia oregonensis H. Magn.
Ochrolechia szatalaensis Verseghy
Ophioparma ventosa (L.) Norman
Orphniospora moriopsis (A. Massal.) D. Hawksw.
Parmelia hygrophila Goward & Ahti
Parmelia omphalodes (L.) Ach.
Parmelia saxatilis (L.) Ach.
Parmelia skultii Hale
Parmelia sulcata Taylor
Parmeliella triptophylla (Ach.) Müll. Arg.
Parmeliopsis ambigua (Wulfen) Nyl.
Parmeliopsis hyperopta (Ach.) Arnold
Peltigera aphthosa (L.) Willd.
Peltigera britannica (Gyelnik) Holt.-Hartw. & Tønsberg
Peltigera canina (L.) Willd.
Peltigera cf. *retifoveata* Vitik.
Peltigera chionophila Goward & Goffinet
Peltigera collina (Ach.) Schrader
Peltigera conspersa Goward ined.
Peltigera extenuata (Vainio) Lojka
Peltigera horizontalis (Hudson) Baumg.
Peltigera lepidophora (Nyl. ex Vainio) Bitter
Peltigera leucophlebia (Nyl.) Gyelnik
Peltigera lyngei Gyeln. ?
Peltigera malacea (Ach.) Funck
Peltigera membranacea (Ach.) Nyl.
Peltigera neopolydactyla (Gyelnik) Gyelnik
Peltigera occidentalis (E. Dahl) Kristinsson
Peltigera polydactylon (Necker) Hoffm.
Peltigera ponojensis Gyelnik
Peltigera praetextata (Flörke ex Sommerf.) Zopf
Peltigera rufescens (Weiss) Humb.
Peltigera scabrosa Th. Fr.
Peltigera scabrosella Holt.-Hartw.
Peltigera venosa (L.) Hoffm.
Pertusaria alpina Hepp ex Ahles
Pertusaria carneopallida (Nyl.) Anzi
Pertusaria dactylina (Ach.) Nyl.
Pertusaria geminipara (Th. Fr.) C. Knight ex Brodo

Pertusaria mccroryae C. R. Björk, Goward & T. Sprib.
Pertusaria oculata (Dickson) Th. Fr.
Pertusaria ophthalmiza (Nyl.) Nyl.
Pertusaria panyrga (Ach.) A. Massal.
Pertusaria subdactylina Nyl.
Pertusaria suboculata Brodo & Dibben
Phaeophyscia cf. *nigricans* (Flörke) Moberg
Phaeophyscia decolor (Kashiw.) Essl.
Phaeophyscia orbicularis (Necker) Moberg
Phaeophyscia sciastra (Ach.) Moberg
Phlyctis argena (Sprengel) Flotow
Phylliscum demangeonii (Moug. & Mont.) Nyl.
Physcia dubia (Hoffm.) Lettau
Physcia phaea (Tuck.) J. W. Thomson
Physconia americana Essl.
Physconia enteroxantha (Nyl.) Poelt
Physconia muscigena (Ach.) Poelt
Physconia perisidiosa (Erichsen) Moberg
Pilophorus acicularis (Ach.) Th. Fr.
Pilophorus clavatus Th. Fr.
Pilophorus dovrensis (Nyl.) Timdal, Hertel & Rambold
Pilophorus nigricaulis Satô
Placidium lachneum (Ach.) Breuss
Placidium lacinulatum var. *atrans* Breuss
Placidium squamulosum (Ach.) Breuss
Placopsis gelida (L.) Lindsay
Placynthiella uliginosa (Schrader) Coppins & P. James
Placynthium asperellum (Ach.) Trevisan
Placynthium flabellosum (Tuck.) Zahlbr.
Placynthium nigrum (Hudson) A. Gray
Platismatia glauca (L.) W. L. Culb. & C. F. Culb.
Platismatia norvegica (Lynge) W. L. Culb. & C. F. Culb.
Plectocarpon lichenum (Sommerf.) D. Hawskw.
Polyblastia cucurbitula J. W. Thomson & B. M. Murray
Polyblastia melaspora (Taylor) Zahlbr.
Polyblastia sendtneri Kremp.
Polychidium muscicola (Sw.) A. Gray
Polysporina simplex (Taylor) Vězda
Porpidia (unknown species, umbonate apothecia)
Porpidia contraponenda (Arnold) Knoph & Hertel
Porpidia crustulata (Ach.) Hertel & Knoph
Porpidia flavicunda (Ach.) Gowan
Porpidia lowiana Gowan
Porpidia melinodes (Körber) Gowan & Ahti
Porpidia sp. nov. (appearance like *Amygdalaria subdissentiens*)
Porpidia thomsonii Gowan
Protopannaria pezizoides (Weber) P. M. Jørg. & S. Ekman
Protoparmelia badia (Hoffm.) Hafellner
Protothelenella sphinctrinoides (Nyl.) H. Mayrhofer & Poelt
Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.
Pseudephebe pubescens (L.) M. Choisy
Pseudocyphellaria anomala Brodo & Ahti
Psora decipiens (Hedwig) Hoffm.
Psora globifera (Ach.) A. Massal.
Psora himalayana (Church. Bab.) Timdal
Psora tuckermanii R. A. Anderson ex Timdal
Psoroma hypnorum (Vahl) A. Gray
Psorula rufonigra (Tuck.) Gotth. Schneider
Pterygiopsis concordatula? (Nyl.) P.M. Jørg.
Pycnora leucococca (R. Sant.) R. Sant.
Pyrenopsis haemalella (Nyl.) Blomb. & Forssell
Ramalina thrausta (Ach.) Nyl.
Ramboldia cinnabarina (Sommerf.) Kalb, Lumbsch & Elix
Ramboldia subcinnabarina (Tønsberg) Kalb, Lumbsch & Elix
Rhizocarpon atroflavescens Lynge
Rhizocarpon badioatrum (Flörke ex Sprengel) Th. Fr.
Rhizocarpon bolanderi (Tuck.) Herre
Rhizocarpon chioneum (Norman) Th. Fr.
Rhizocarpon concentricum (Davies) Beltr.
Rhizocarpon copelandii (Körber) Th. Fr.
Rhizocarpon disporum (Nägeli ex Hepp) Müll. Arg.
Rhizocarpon geminatum Körber
Rhizocarpon geographicum (L.) DC.
Rhizocarpon grande (Flörke ex Flotow) Arnold
Rhizocarpon lavatum (Fr.) Haszl.
Rhizocarpon lecanorinum Anders
Rhizocarpon oederi (Weber) Körber

Rhizocarpon ridescens (Nyl.) Zahlbr.
Rinodina mniaraea var. *cinnamomea* Th. Fr.
Rinodina mniaraea var. *mniaraea* (Ach.) Körb.
Rinodina mniaraea var. *mniaraeiza* (Nyl.) H. Magn.
Rinodina olivaceobrunnea C. W. Dodge & Baker
Rinodina terrestris Tomin
Rinodina turfacea (Wahlenb.) Körber
Schaereria corticola Muhr & Tønsberg
Solorina bispora Nyl.
Solorina crocea (L.) Ach.
Solorina octospora (Arnold) Arnold
Solorina saccata (L.) Ach.
Solorina spongiosa (Ach.) Anzi
Sphaerophorus fragilis (L.) Pers.
Sphaerophorus globosus (Hudson) Vainio
Sphaerophorus tuckermanii Räsänen
Sphaerophorus venerabilis Wedin, Högnabba & Goward
Spilonema revertens Nyl.
Sporastatia unknown species, radially cracked apothecia
Staurothele areolata (Ach.) Lettau
Staurothele drummondii (Tuck.) Tuck.
Staurothele fissa (Taylor) Zwackh
Steineropsis alaskana T. Sprib. & Muggia
Stereocaulon alpinum Laurer ex Funck
Stereocaulon arcticum Lynge
Stereocaulon arenarium (Savicz) I. M. Lamb
Stereocaulon botryosum Ach.
Stereocaulon capitellatum H. Magn.
Stereocaulon cf. *intermedium* (Savicz) H. Magn.
Stereocaulon cf. *uliginosum* I. M. Lamb
Stereocaulon cumulatum (Sommerf.) Timda
Stereocaulon depressum (Frey) I. M. Lamb
Stereocaulon glareosum (Savicz) H. Magn.
Stereocaulon grande (H. Magn.) H. Magn.
Stereocaulon intermedium (Savicz) H. Magn.
Stereocaulon klondikense T. Sprib.
Stereocaulon nivale (Follmann) Fryday
Stereocaulon paschale (L.) Hoffm.
Stereocaulon rivulorum H. Magn.
Stereocaulon spathuliferum Vainio
Stereocaulon symphycheilum I. M. Lamb
Stereocaulon tomentosum Fr.
Stereocaulon vesuvianum Pers.
Strangospora moriformis (Ach.) Stein
Tephromela atra (Hudson) Hafellner
Thamnolia vermicularis (Sw.) Ach. ex Schaerer
Thermutis velutina (Ach.) Flotow
Toninia ruginosa (Tuck.) Herre
Trapeliopsis granulosa (Hoffm.) Lumbsch
Tremolecia atrata (Ach.) Hertel
Tuckermannopsis chlorophylla (Willd.) Hale
Umbilicaria angulata Tuck.
Umbilicaria aprina Nyl. ?
Umbilicaria arctica (Ach.) Nyl.
Umbilicaria cf. *torrefacta* (Lightf.) Schrader (reticulate black below)
Umbilicaria cylindrica (L.) Delise ex Duby
Umbilicaria deusta (L.) Baumg.
Umbilicaria havaasii Llano
Umbilicaria hyperborea (Ach.) Hoffm.
Umbilicaria lambii Imshaug
Umbilicaria muhlenbergii (Ach.) Tuck.
Umbilicaria proboscidea (L.) Schrader
Umbilicaria sp. nov.
Umbilicaria torrefacta (Lightf.) Schrader
Umbilicaria virginis Schaerer
Vahliella leucophaea (Vahl) P. M. Jørg.
Varicellaria rhodocarpa (Körber) Th. Fr.
Verrucaria margacea (Wahlenb.) Wahlenb.
Vestergrenopsis elaeina (Wahlenb.) Gyelnik
Vestergrenopsis isidiata (Degel.) E. Dahl
Vulpicida pinastri (Scop.) Mattsson & M.J. Lai
Xanthoria candelaria (L.) Th. Fr.
Xanthoria elegans (Link) Th. Fr.
Xanthoria sorediata (Vainio) Poelt
Xylographa parallela (Ach. : Fr.) Behlen & Desberger
Xylographa soralifera Holien & Tønsberg

LIVERWORTS

Anastrophyllum michauxii (F. Weber) H. Buch ex A. Evans
Anastrophyllum minutum (Schreb.) R.M. Schust.
Anastrophyllum sphenoloboides R.M. Schust.
Aneura pinguis (L.) Dumort.
Anthelia julacea (L.) Dum.
Anthelia juratzkana (Limpr.) Trev.
Asterella gracilis (Web.) Underw. group
Asterella lindenbergiana (Corda) Lindb.
Barbilophozia floerkii (Web. and Mohr) Loeske
Barbilophozia hatcheri (A. Evans) Loeske
Barbilophozia kunzeana (Huebener) K. Müller
Barbilophozia lycopodioides (Wallr.) Loeske
Blasia pusilla L.
Blechnum spicant (L.) Sm.
Blepharostoma trichophyllum (L.) Dumort.
Calypogeia integristipula Stephani
Calypogeia muelleriana (Schiffner) K. Müller
Calypogeia sphagnicola (Arnell & J. Perss.) Warnst. & Loeske
Cephalozia bicuspidata (L.) Dumort.
Cephalozia catenulata (Huebener) Lindb.
Cephalozia connivens (Dicks.) Lindb.
Cephaloziella divaricata var. *divaricata* (Sm.) Schiffn.
Cephaloziella spinigera (Lindb.) Jörg.
Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort.
Chiloscyphus polyanthos (L.) Corda
Chiloscyphus rivularis (Schrad.) Hazsl.
Cladopodiella fluitans (Nees) Jörg.
Conocephalum conicum (L.) Underw.
Diplophyllum taxifolium (Wahlenb.) Dumort.
Gymnocolea inflata (Huds.) Dumort.
Gymnomitrion concinnatum (Lightf.) Corda
Gymnomitrion corallioides Nees
Gymnomitrion obtusum (Lindb.) Pearson
Gymnomitrion pacificum Grolle
Harpanthus flotowianus (Nees) Nees
Jungermannia borealis Damsh. & Váňa
Jungermannia eucordifolia Schlj.
Jungermannia exsertifolia Stephani
Lophozia porphyroleuca (Nees) Schiffner
Lophozia turbinata Stephani
Lophozia ventricosa (Dicks.) Dumort.
Marchantia alpina Schleich.
Marchantia polymorpha L.
Marsupella boeckii (Austin) Lindb. ex Kaal.
Marsupella brevissima (Dumort.) Grolle
Marsupella emarginata (Ehrh.) Dumort.
Marsupella sphacelata (Giesecke ex Lindenb.) Dumort.
Marsupella ustulata (Huebener) Spruce ex Pearson
Moerckia blyttii (Moerck ex Hornem.) Brockm.
Moerckia hibernica (Hook.) Gottsche
Mylia taylorii (Hook.) Gray
Nardia geoscyphus (De Not.) Lindb.
Nardia scalaris (Schrad.) Gray
Pellia endiviifolia (Dicks.) Dumort.
Pellia neesiana (Gottsche) Limpr.
Pleurocladula albescens (Hook.) Grolle
Porella cordeana (Hüb.) Moore
Preissia quadrata (Scop.) Nees
Ptilidium californicum (Austin) Underw.
Ptilidium ciliare (L.) Hampe
Ptilidium pulcherrimum (Weber) Hampe
Radula complanata (L.) Dumort.
Sauteria alpina (Nees & Bisch.) Nees
Scapania americana K. Müller
Scapania bolanderi Austin
Scapania irrigua (Nees) Nees
Scapania obcordata (Berggr.) S.W. Arnell
Scapania obscura (Arnell & C.E.O. Jensen) Schiffner ?
Scapania paludosa (K. Müller) K. Müller
Scapania subalpina (Nees ex Lindenb.) Dumort.
Scapania uliginosa (Lindenb.) Dumort.
Scapania undulata (L.) Dumort. ?
Schistochilopsis incisa (Schrad.) Konstantinova
Schistochilopsis opacifolia (Culm.) Konstantinova
Schofieldia monticola J.D. Godfrey
Schofieldia monticola J.D. Godfrey
Tetralophozia setiformis (Ehrh.) Schljakov

Tritomaria exectiformis (Breidl.) Loeske

Tritomaria quinquedentata (Huds.) H. Buch

MOSSES

Amblyodon dealbatus? (Sw. ex Hedw.) Bruch & Schimp.
Amblystegium serpens (Hedw.) Schimp.
Amphidium lapponicum (Hedw.) Schimp.
Amphidium mougeotii (Bruch & Schimp.) Schimp
Andreaea blyttii Schimp.
Andreaea nivalis Hook.
Andreaea rupestris Hedw.
Andreaea sinuosa B.M. Murray
Antitrichia curtipendula (Timm ex Hedw.) Brid.
Aongstroemia longipes (Sommerf.) Bruch & Schimp.
Arctoa fulvella (Dicks.) Bruch & Schimp.
Atrichum tenellum (Röhl.) Bruch & Schimp.
Aulacomnium androgynum (Hedw.) Schwägr.
Aulacomnium palustre (Hedw.) Schwägr.
Barbula convoluta Hedw.
Batramia ithyphylla Brid.
Blindia acuta (Hedw.) Bruch & Schimp.
Brachytheciastrum leibergii (Grout) Ignatov & Huttunen
Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen var. *velutinum*
Brachythecium acutum (Mitt.) Sull.
Brachythecium albicans (Hedw.) Schimp.
Brachythecium cirrhosum Schw.
Brachythecium frigidum (Müll. Hal.) Besch.
Brachythecium salebrosum (Web. & Mohr) Schimp.
Bryum calobryoides Spence
Bucklandiella affinis? (Schleich. ex F. Weber & D. Mohr) Bednarek-Ochyra & Ochyra
Bucklandiella heterosticha (Hedw.) Bednarek-Ochyra & Ochyra
Bucklandiella macounii (Kindb.) Bednarek-Ochyra & Ochyra
Bucklandiella sudetica (Funck) Bednarek-Ochyra & Ochyra
Buxbaumia aphylla Hedw.
Calliergonella cuspidata (Hedw.) Loeske
Campylium stellatum (Hedw.) C.E.O. Jensen
Ceratodon purpureus (Hedw.) Brid.
Cinclidium stygium Sw.
Claopodium bolanderi Best
Codriophorus aciculare (Hedw.) P. Beauv.
Codriophorus mollis (Cardot) Bednarek-Ochyra & Ochyra
Conostomum tetragonum (Hedw.) Lindb.
Cratoneuron filicinum (Hedw.) Spruce
Cynodontium schisti (F. Weber & D. Mohr) Lindb.
Cynodontium tenellum (Schimp.) Limpr.
Dichodontium olympicum Renauld & Cardot
Dichodontium pellucidum (Hedw.) Schimp.
Dicranella palustris (Dicks.) A.C. Crundwell
Dicranoweisia cirrata (Hedw.) Lindb.
Dicranoweisia crispula (Hedw.) Milde
Dicranum acutifolium (Lindb. & Arnell) C.E.O. Jensen
Dicranum brevifolium (Lindb.) Lindb.
Dicranum fuscescens Turner
Dicranum montanum Hedw.
Dicranum muehlenbeckii Bruch & Schimp.
Dicranum pallidisetum (J.W. Bailey) Ireland
Dicranum scoparium Hedw.
Dicranum spadiceum J.E. Zetterst.
Dicranum tauricum Sapjegin
Didymodon fallax (Hedw.) R.H. Zander
Didymodon rigidulus Hedwig var. *rigidulus*
Didymodon rigidulus var. *icmadophilus* (Schimp. ex Müll. Hal.) R.H. Zander
Distichium capillaceum (Hedw.) Bruch & Schimp.
Distichium inclinatum (Hedw.) Bruch & Schimp.
Ditrichum cf. *ambiguum* Best
Ditrichum flexicaule (Schwägr.) Hampe
Ditrichum gracile (Mitt.) Kuntze
Ditrichum montanum Leiberg
Drepanocladus aduncus (Hedw.) Warnst.
Drepanocladus polygamus (Schimp.) Hedenas
Dryptodon patens (Dicks. ex Hedw.) Brid.
Encalypta affinis R. Hedw. (macounii form)
Encalypta longicollis Bruch
Encalypta procera Bruch
Encalypta rhapdocarpa Schwägr.
Encalypta vulgaris Hedw.
Eurhynchium pulchellum (Hedw.) Jenn.
Fissidens osmundoides Hedw.
Gemmabryum caespiticium (Hedw.) J.R. Spence
Gemmabryum dichotomum (Hedw.) J.R. Spence & H.P. Ramsay
Gemmabryum subapiculatum (Hampe) J.R.

Spence & H.P. Ramsay?
Grimmia alpestris (F. Weber & D. Mohr) Schleich.
Grimmia sessitana De Not.
Grimmia torquata Drumm.
Hedwigia ciliata (Hedw.) P. Beauv.
Helodium blandowii (F. Weber & D. Mohr) Warnst.
Helodium paludosum (Austin) Broth.
Homalothecium aeneum (Mitt.) E. Lawton
Hydrothyria venosa J. L. Russell
Hygroamblystegium tenax (Hedw.) Jenn.
Hygrohypnum eugyrium (Schimp.) Loeske
Hygrohypnum luridum (Hedw.) Jenn.
Hygrohypnum ochraceum (Turner ex Wilson) Loeske
Hygrohypnum smithii (Sw.) Broth.
Hylocomium splendens (Hedw.) Schimp.
Hypnum bambergeri Schimp.
Hypnum circinale Hook.
Imbribryum alpinum (Huds. ex With.) N. Pedersen
Imbribryum gemmiparum (De Not.) J.R. Spence? (needs verification)
Imbribryum unknown species (laminal cells quadrate and stiff, leaves red and linear-lanceolate)
Isopterygiopsis pulchella (Hedw.) Z. Iwats.
Isothecium stoloniferum Brid.
Kiaeria blyttii (Bruch & Schimp.) Broth.
Kiaeria falcata (Hedw.) I. Hagen
Kiaeria starkei (Weber & D. Mohr) I. Hagen
Leptobryum pyriforme (Hedw.) Wilson
Leptodictyum riparium (Hedw.) Warnst.
Loeskypnum badium (Hartm.) H.K.G. Paul
Meesia uliginosa Hedw.
Mielichhoferia elongata (Hoppe & Hornsch.) Nees & Hornsch.
Mnium blyttii Bruch & Schimp.
Mnium lycopodioides Schwägr.
Mnium spinulosum Bruch & Schimp.
Neckera menziesii Drumm.
Niphotrichum canescens ssp. *latifolium* (C.E.O.Jens.) Frisvoll
Niphotrichum ericoides (Brid.) Bednarek-Ochyra & Ochyra
Niphotrichum muticum (Kindb.) Bednarek-Ochyra & Ochyra
Niphotrichum pygmaeum (Frisvoll) Bednarek-Ochyra & Ochyra
Oligotrichum parallelum (Mitt.) Kindb.
Oncophorus virens (Hedwig) Bridel
Oncophorus wahlenbergii Bridel
Orthotrichum laevigatum J. E. Zetterstedt
Orthotrichum speciosum Nees
Paludella squarrosa (Hedw.) Brid.
Palustriella falcata (Brid.) Hedenas
Philonotis capillaris Lindb.
Philonotis fontana var. *americana* (Dism.) Flowers ex H.A. Crum
Philonotis fontana var. *fontana* (Hedw.) Brid.
Plagiobryum demissum (Hook.) Lindb.
Plagiomnium ellipticum (Brid.) T.J. Kop.
Plagiomnium medium (Bruch & Schimp.) T.J. Kop.
Plagiothecium laetum Schimp.
Platanthera aquilonis Sheviak
Platydictya jungermannioides (Brid.) H.A. Crum
Pleurozium schreberi (Willd. ex Brid.) Mitt.
Pogonatum contortum (Menzies ex Brid.) Lesq.
Pogonatum urnigerum (Hedw.) P. Beauv.
Pohlia atropurpurea (Wahlenb.) H. Lindb.
Pohlia cardotii (Renauld) Broth.
Pohlia cruda (Hedw.) S.O. Lindberg
Pohlia drummondii (Müll. Hal.) A.L. Andrews
Pohlia filum (Schimp.) Martensson
Pohlia lescuriana (Sull.) Ochi
Pohlia ludwigii (Spreng. ex Schwägr.) Broth.
Pohlia nutans (Hedw.) S.O. Lindberg
Pohlia proligera (Kindb.) Broth.
Pohlia sp. nov.
Pohlia wahlenbergii (F. Weber & D. Mohr) A.L. Andrews
Polytrichastrum alpinum var. *alpinum* (Hedw.) G.L. Sm.
Polytrichum commune Hedw.
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Polytrichum strictum Menzies ex Brid.
Pseudocalliergon angustifolium Hedenäs
Pseudocalliergon trifarium (F. Weber & D. Mohr) Loeske
Pseudoleskea atricha (Kindb.) Kindb.
Pseudoleskea baileyi Best & Grout
Pseudoleskea incurvata (Hedw.) Loeske var. *incurvata*
Pseudoleskea sp. (like *P. atricha* but leaves acuminate and cells only weakly prorate)
Psilopilum cavifolium (Wilson) I. Hagen
Ptilium crista-castrensis (Hedw.) De Not.

Ptychostomum archangelicum (Bruch & Schimp.) J.R. Spence
Ptychostomum bimum (Schreb.) J.R. Spence
Ptychostomum pallens (Sw.) J.R. Spence
Ptychostomum pallescens (Schleich. ex Schwägr.) J.R. Spence
Ptychostomum pendulum Hornsch.
Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P. Ramsay
Ptychostomum schleicheri (Schwägr.) J.R. Spence
Ptychostomum turbinatum (Hedw.) J.R. Spence
Ptychostomum weigelii (Spreng.) J.R. Spence
Racomitrium lanuginosum (Hedw.) Brid.
Rhizomnium magnifolium (Horik.) T.J. Kop.
Rhizomnium nudum (R.S. Williams) T.J. Kop.
Rhizomnium pseudopunctatum (Bruch & Schimp.) T.J. Kop.
Rhytidiadelphus loreus (Hedw.) Warnst.
Rhytidiadelphus subpinnatus (Lindb.) T.J. Kop.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidiopsis robusta (Hook.) Broth.
Rhytidium rugosum (Hedw.) Kindb.
Roellia roellii (Broth.) A.L. Andrews ex H.A. Crum
Sanionia georgicouncinata (Müll. Hal.) Ochyra
Sanionia orthothecioides (Lindb.) Loeske
Sanionia uncinata (Hedw.) Loeske
Sarmentypnum exannulatum (Schimp.) Hedenäs
Sarmentypnum pseudosarmentosum (Cardot & Thériot) Hedenäs
Sarmentypnum tundrae (Arnell) Hedenas
Schistidium agassizii Sull. & Lesq.
Schistidium apocarpum (Hedw.) Bruch & Schimp.
Schistidium cf. *atrichum* (Müll. Hal. & Kindb.) W.A. Weber
Schistidium cf. *frisvolleanum* H.H. Blom
Schistidium frigidum H.H. Blom
Schistidium rivulare (Brid.) Podp.
Sciuro-hypnum oedipodium (Mitt.) Ignatov & Huttunen
Sciurohypnum hylotapetum (N. Higinbotham & B. Higinbotham) Ignatov & Huttunen
Sciurohypnum latifolium (Kindb.) Ignatov et Huttunen
Sciurohypnum populeum (Hedwig) Ignatov & Huttunen
Scorpidium revolvens (Sw.) Rubers
Sphagnum angustifolium (Warnst.) C.E.O. Jensen
Sphagnum annulatum Warnst.
Sphagnum aongstroemii C. Hartm.
Sphagnum capillifolium (Ehrh.) Hedw.
Sphagnum centrale C.E.O. Jensen
Sphagnum compactum Lam. & DC.
Sphagnum fallax H. Klinggr.
Sphagnum fimbriatum Wilson
Sphagnum girgensohnii Russow
Sphagnum lindbergii Schimp.
Sphagnum pacificum Flatberg
Sphagnum quinquefarium (Lindb.) Warnst.
Sphagnum riparium Ångström
Sphagnum rubellum Wilson
Sphagnum russowii Warnst.
Sphagnum squarrosum Crome
Sphagnum subfulvum Sjors
Sphagnum subnitens Russow & Warnst.
Sphagnum subsecundum Nees
Sphagnum tenellum (Brid.) Brid.
Sphagnum teres (Schimp.) Ångström
Straminergon stramineum (Dicks. ex Brid.) Hedenäs
Syntrichia montana Nees
Syntrichia princeps (De Not.) Mitt.
Syntrichia ruralis (Hedw.) F. Weber & D. Mohr
Tayloria lingulata (Dicks.) S.O. Lindberg
Tetraplodon mnioides (Sw. ex Hedw.) Bruch & Schimp.
Thamnobryum neckeroides (Hook.) E. Lawton
Timmia austriaca Hedw.
Tomentypnum falcifolium (Renauld ex Nichols) Tuom.
Tomentypnum nitens (Hedw.) Loeske
Tortella fragilis (Hook. & Wilson) Limpr.
Tortella tortuosa (Hedwig) Limpricht var. *tortuosa*
Warnstorfia fluitans (Hedw.) Loeske

VASCULAR PLANTS

Abies lasiocarpa (Hook.) Nutt.
Acer glabrum Torr.
Achillea millefolium var. *borealis* (Bong.) Farw.
Achnatherum nelsonii ssp. *dorei* (Barkworth & J. Maze) Barkworth
Aconitum delphiniifolium DC.
Actaea rubra (Aiton) Willd.
Adiantum aleuticum (Rupr.) C.A. Paris
Agoseris aurantiaca (Hook.) E. Greene ssp. *aurantiaca*
Agrostis capillaris L.
Agrostis exarata Trin.
Agrostis mertensii Trin.
Agrostis scabra Willd.
Agrostis stolonifera L.
Alnus viridis ssp. *sinuata* (Regel) Á. Löve & D. Löve
Amelanchier florida Lindl.
Anaphalis margaritacea (L.) Benth.
Anemone multifida Poir. ssp. *saxicola*
Anemone parviflora Michx.
Anemone richardsonii Hook.
Antennaria alpina (L.) Gaertn.
Antennaria howellii E. Greene x *A. alpina* (L.) Gaertn.
Antennaria media E. Greene
Antennaria monocephala ssp. *angustata* (E. Greene) Hultén
Antennaria monocephala ssp. *monocephala* DC.
Antennaria rosea ssp. *confinis* (E. Greene) Bayer
Antennaria umbrinella Rydb.
Aquilegia formosa Fisch. ex DC.
Arabidopsis lyrata ssp. *kamchatica* (Fisch. ex DC.) O'Kane & Al-Shehbaz
Arabis eschscholtziana Andrz.
Arctostaphylos uva-ursi (L.) Spreng.
Arctous alpina (L.) Nied.
Arnica chamissonis ssp. *foliosa* (Nutt.) Maguire
Arnica gracilis Rydb.
Arnica griscomii ssp. *frigida* (C.A.Mey. ex Iljin) S.J.Wolf
Arnica lanceolata ssp. *prima* (Maguire) Strother & S.J.Wolf
Arnica latifolia Bong.
Arnica mollis Hook.
Artemisia campestris L.
Artemisia michauxiana Besser ssp. nov
Artemisia norvegica Fr.
Aruncus dioica (Walter) Fernald
Asplenium viride Huds.
Athyrium americanum (Butters) Maxon
Athyrium filix-femina var. *cyclosorum* Rupr.
Betula papyrifera Marshall
Bistorta vivipara (L.) Delarbre
Boechera collinsii (Fernald) Á. Löve & D. Löve
Boechera divaricarpa (A. Nelson) Á. Löve & D. Löve
Boechera grahamii (Lehm.) Windham & Al-Shehbaz
Boechera macounii (S. Watson) Windham & Al-Shehbaz
Boechera retrofracta (Graham) Á. Löve & D. Löve
Boechera stricta (Graham) Al-Shehbaz
Botrychium cf. *spathulatum* W.H. Wagner
Botrychium crenulatum W.H. Wagner
Botrychium lunaria (L.) Sw.
Botrychium minganense Vict.
Botrychium pinnatum H. St. John
Bromus ciliatus L.
Bromus marginatus Nees ex Steud.
Bromus vulgaris (Hook.) Shear
Calamagrostis canadensis (Michx.) P. Beauv.
Calamagrostis purpurascens R. Br.
Caltha biflora DC.
Campanula lasiocarpa Cham.
Campanula rotundifolia L.
Cardamine bellidifolia L.
Cardamine umbellata E. Greene
Carex albonigra Mack
Carex anthoxanthea J.Presl & C.Presl
Carex aquatilis Wahlenb.
Carex atrosquama Mack.
Carex aurea Nutt.
Carex brunnescens (Pers.) Poir.
Carex canescens ssp. *canescens* L.
Carex cf. *heleonastes* Ehrh. ex L. f.
Carex enanderi Hultén
Carex flava L.
Carex garberi Fernald
Carex hoodii Boott
Carex illota L.H. Bailey
Carex lachenalii Schkuhr
Carex lenticularis var. *limnophila* (T. Holm) Cronquist

Carex lenticularis var. *lipocarpa* (T. Holm) L.A. Standl.
Carex macloviana D'Urv.
Carex macrochaeta C.A. Mey.
Carex magellanica ssp. *irrigua* (Wahlenb.) Hultén
Carex mertensii J.D. Prescott ex Bong.
Carex micropoda C.A. Mey.
Carex nardina Fr.
Carex nigricans C.A. Mey.
Carex pauciflora Lightf.
Carex phaeocephala Piper
Carex praeceptorum Mack.
Carex rossii Boott
Carex rostrata Stokes x *C. utriculata* Boott
Carex saxatilis L.
Carex scirpoidea ssp. *scirpoidea* Michx.
Carex sitchensis Prescott ex Bong.
Carex sp. nov. (similar to *C. atrata*)
Carex spectabilis Dewey
Carex stylosa C.A. Mey.
Carex tahoensis Smiley
Cassiope mertensiana (Bong.) G. Don
Cassiope tetragona (L.) D. Don
Castilleja miniata Dougl. ex Hook.
Castilleja parviflora Bong.
Castilleja unalaschcensis (Cham. & Schltdl.) Malte
Cerastium arvense L. (silvery, lowland form)
Cerastium arvense L. (green, alpine form)
Chimaphila umbellata (L.) W.P.C. Barton
Cinna latifolia (Trevir.) Griseb.
Cirsium edule Nutt.
Clintonia uniflora (Menzies ex Schult. & Schult. f.) Kunth
Collinsia parviflora Lindl.
Collomia linearis Nutt.
Comarum palustre L.
Cornus canadensis L.
Cornus stolonifera Michx.
Cornus unalaschkensis Ledeb.
Cryptogramma acrostichoides R. Br.
Cryptogramma sitchensis (Rupr.) T. Moore
Cystopteris fragilis (L.) Bernh. (erect, stiff, non-glandular form)
Cystopteris fragilis (L.) Bernh. normal form
Cystopteris sp. nov.
Danthonia intermedia Vasey
Danthonia spicata (L.) Roem. & Schult.
Diphasiastrum alpinum (L.) Holub
Diphasiastrum sitchense (Rupr.) Holub
Disporum trachycarpum (S.Watson) Benth. & Hook.f.
Draba aurea Vahl ex Hornem.
Draba crassifolia Graham
Draba glabella Pursh
Draba lonchocarpa Rydb.
Draba macounii O.E. Schulz
Draba nivalis Lilj.
Draba praealta E. Greene
Draba ruaxes Payson & H. St. John
Draba sp. nov.
Draba stenoloba Ledeb.
Dryas drummondii Richardson ex Hook.
Dryas integrifolia Vahl
Drymocallis glandulosa (Lindl.) Rydb.
Dryopteris expansa (C. Presl) Fraser-Jenk. & Jermy
Dryopteris filix-mas (L.) Schott
Elliottia pyroliflora (Bong.) S.W.Brim & P.F.Stevens
Elymus alaskanus ssp. *alaskanus* (Scribn. & Merr.) Á. Löve
Elymus glaucus Buckley
Elymus hirsutus J.Presl
Elymus trachycaulus ssp. *subsecundus* (Link) Á. Löve & D. Löve
Elymus trachycaulus ssp. *trachycaulus* (Link) Gould ex Shinners
Empetrum nigrum L.
Epilobium anagallidifolium Lam.
Epilobium angustifolium L.
Epilobium ciliatum ssp. *ciliatum* Raf.
Epilobium ciliatum ssp. *glandulosum* (Lehm.) Hoch & P.H. Raven
Epilobium clavatum Trel.
Epilobium davuricum Fisch. ex Hornem.
Epilobium hornemannii ssp. *behringianum* (Hausskn.) Hoch & P.H. Raven
Epilobium hornemannii ssp. *hornemannii* Rchb.
Epilobium lactiflorum Hausskn.
Epilobium latifolium L.
Epilobium leptocarpum Hausskn.
Epilobium luteum Pursh
Epilobium minutum Lindl. ex Lehm.
Epilobium palustre L.
Epilobium x *treleasianum* H. Lév.
Equisetum arvense L.
Equisetum fluviatile L.
Equisetum variegatum Schleich. ex F. Weber & D. Mohr

Erigeron acris var. *kamtschaticus* (DC.) Herder
Erigeron compositus Pursh
Erigeron glacialis (Nutt.) A. Nelson
Erigeron humilis Graham
Erigeron nivalis Nutt.
Erigeron peregrinus (Banks ex Pursh) E. Greene var. *peregrinus*
Eriophorum angustifolium Honck.
Erythranthe guttata (Fischer ex de Candolle) G.L. Nesom
Erythranthe lewisii (Pursh) G.L. Nesom & N.S. Fraga
Fauria crista-galli (Griseb.) Makino
Festuca altaica Trin.
Festuca brachyphylla Schult. & Schult. f.
Festuca cf. *baffinensis* Polunin
Festuca cf. *groenlandica* (Schol.) Fred.
Festuca occidentalis Hook.
Festuca saximontana var. *purpusiana* (St.-Yves) Fred. & Pavlick
Festuca saximontana var. *saximontana* Rydb.
Fragaria vesca L.
Galium trifidum L.
Galium triflorum Michx.
Gentiana glauca Pall.
Gentiana platypetala Griseb.
Gentianella propinqua ssp. *propinqua* (Richardson) J.M. Gillett
Geranium erianthum DC.
Geum aleppicum Jacq.
Geum macrophyllum Willd. var. *macrophyllum*
Goodyera oblongifolia Raf.
Gymnocarpium × *intermedium* Sarvela
Gymnocarpium disjunctum (Rupr.) Ching
Gymnocarpium dryopteris (L.) Newman
Gymnocarpium jessoense (Koidz.) Koidz.
Harrimanella stelleriana (Pall.) Coville
Heracleum lanatum Michx.
Heuchera glabra Willd. ex Roem. & Schult.
Heuchera micrantha var. *diversifolia* (Rydb.) Rosend., Butters & Lakela
Hieracium albiflorum Hook.
Hieracium gracile Froel.
Hieracium triste Willd. ex Spreng.
Hierochloe alpina (Sw. ex Willd.) Roem. & Schult.
Hippuris montana Ledeb. ex Rchb.
Hippuris vulgaris L.
Huperzia arctica (Grossh. ex Tolm.) Sipliv.
Huperzia chinensis (H. Christ) Ching
Huperzia haleakalae (Brack.) Holub
Huperzia occidentalis (Clute) Kartesz & Gandhi
Juncus alpinoarticulatus Chaix
Juncus arcticus var. *sitchensis* Engelm.
Juncus biglumis L.
Juncus castaneus Sm.
Juncus drummondii E. Mey.
Juncus ensifolius Wikstr. var. *ensifolius*
Juncus filiformis L.
Juncus mertensianus Bong.
Juniperus communis L.
Kalmia microphylla (Hook.) A. Heller
Kobresia simpliciuscula (Wahlenb.) Mack.
Leptarrhena pyrolifolia (D. Don) R. Br. ex Ser.
Listera cordata (L.) R. Br.
Lloydia serotina var. *serotina* (L.) Salisb. ex Rchb.
Loiseleuria procumbens (L.) Desv.
Luetkea pectinata (Pursh) Kuntze
Lupinus nootkatensis Donn ex Sims var. *nootkatensis*
Luzula arcuata (Wahlenb.) Sw.
Luzula parviflora (Ehrh.) Desv.
Luzula piperi (Coville) M.E. Jones
Luzula spicata (L.) DC.
Luzula wahlenbergii Rupr.
Lycopodium annotinum ssp. *pungens* (Bach. Pyl.) Hultén
Lycopodium clavatum L.
Lycopodium lagopus (Laestadius ex C. Hartman) G. Zinserling ex Kuzeneva-Prochorova
Lysichiton americanus Hultén & H.St.John
Maianthemum racemosum (L.) Link
Maianthemum stellatum (L.) Link
Melampyrum lineare Desr.
Melica subulata (Griseb.) Scribn.
Menziesia ferruginea Sm.
Micranthes ferruginea (Graham) Brouillet & Gornall
Micranthes lyallii (Engl.) Small
Micranthes nelsoniana var. carlottae (Calder & Savile) Gornall & H. Ohba
Micranthes nelsoniana var. nov.
Micranthes nelsoniana var. *porsildiana* (Calder & Savile) Gornall & H. Ohba
Micranthes nivalis (L.) Small
Micranthes occidentalis (S. Watson) Small
Micranthes tenuis (Wahlenb.) Small
Micranthes tolmiei (Torr. & A. Gray) Brouillet & Gornal

Minuartia biflora (L.) Schinz & Thell.
Minuartia obtusiloba (Rydb.) House
Minuartia rubella (Wahlenb.) Hiern
Mitella breweri A. Gray
Mitella pentandra Hook.
Montia parvifolia (Moc. ex DC.) E. Greene
Myosotis asiatica (Vestergr.) Schischk. & Serg.
Nuphar variegatum Engelm.
Oplopanax horridus (Sm.) Miq.
Orthilia secunda (L.) House
Osmorhiza berteroi DC.
Osmorhiza purpurea (J.M. Coult. & Rose) Suksd.
Oxyria digyna (L.) Hill
Packera indecora (E. Greene) A. Löve & D. Löve
Parnassia fimbriata K.D. Koenig
Parnassia kotzebuei Cham. ex Spreng.
Paxistima myrsinites (Pursh) Raf.
Pedicularis ornithorhyncha Benth.
Pedicularis sudetica Willd.
Penstemon serrulatus Menzies ex Rees
Petasites nivalis E. Greene
Phegopteris connectilis (Michx.) Watt
Phleum alpinum L.
Phleum pratense L.
Phyllodoce glanduliflora (Hook.) Coville
Picea sitchensis (Bong.) Carrière
Pinguicula vulgaris L.
Piperia unalascensis (Spreng.) Rydb.
Platanthera dilatata var. *dilatata* (Pursh) Lindl. ex L.C. Beck
Platanthera stricta Lindl.
Poa abbreviata R. Br.?
Poa alpina L.
Poa annua L.
Poa arctica ssp. *arctica* R. Br.
Poa arctica ssp. *grayana* (Vasey) Á. Löve, D. Löve & B.M. Kapoor
Poa arctica ssp. *lanata* (Scribn. & Merr.) Soreng
Poa compressa L.
Poa cusickii ssp. *epilis* (Scribn.) W.A. Weber
Poa cusickii ssp. *pallida* Soreng
Poa glauca ssp. *rupicola* (Nash) W.A. Weber
Poa interior Rydb.
Poa leptocoma Trin.
Poa nemoralis L.
Poa palustris L.
Poa paucispicula Scribn. & Merr.
Poa pratensis ssp. *colpodea* (Th. Fr.) Tzvelev
Poa pratensis ssp. *pratensis* L.
Poa scabrella (Thurb.) Benth. ex Vasey
Podagrostis humilis (Vasey) Björkman
Polemonium elegans E. Greene
Polygonum minimum S. Watson
Polygonum sawatchense Small
Polypodium cf. *interjectum* Shivas
Polypodium hesperium Maxon
Polystichum andersonii Hopkins
Polystichum lonchitis (L.) Roth
Populus balsamifera L.
Populus tremuloides Michx.
Populus trichocarpa Torr. & A. Gray
Potamogeton epihydrus Raf. ? (couldn't collect, out of reach in an open water pool)
Potamogeton gramineus L.
Potentilla arenosa (Turcz.) Juz.
Potentilla arenosa (Turcz.) Juz. x *P. nivea* L.
Potentilla concinna Richardson ?
Potentilla glaucophylla var. *glaucophylla* Lehm.
Potentilla hyparctica var. *elatior* (Abrom.) Fernald
Potentilla nana Willd. ex Schltdl.
Potentilla rubricaulis Lehm.
Potentilla villosula Jurtzev
Prenanthes alata (Hook.) D.Dietr.
Prunella vulgaris L.
Pyrola asarifolia Michx.
Pyrola minor L.
Ranunculus cooleyae Vasey & Rose ex Rose
Ranunculus eschscholtzii Schltdl.
Ranunculus gelidus Kar. & Kir.
Ranunculus nivalis L.
Ranunculus occidentalis var. *hexasepalus* L.D. Benson
Ranunculus pensylvanicus L. f.
Ranunculus pygmaeus Wahlenb.
Ranunculus repens L.
Ranunculus uncinatus D. Don
Rhodiola integrifolia Raf.
Ribes bracteosum Douglas ex Hook.
Ribes hudsonianum Richardson
Ribes lacustre (Pers.) Poir.
Ribes laxiflorum Pursh
Romanzoffia sitchensis Bong.
Rubus arcticus L.
Rubus idaeus L.
Rubus parviflorus Nutt.
Rubus pedatus Sm.
Rubus spectabilis Pursh
Rumex lapponicus (Hiitonen) Czernov
Sagina procumbens L.

Sagina saginoides (L.) H. Karst.
Salix alaxensis var. *alaxensis* (Anderss.) Coville
Salix alaxensis var. *longistylis* (Rydb.) C.K. Schneid.
Salix arctica Pall.
Salix barclayi Andersson
Salix barrattiana Hook.
Salix cf. *phlebophylla* Andersson
Salix cf. *polaris* Wahlenb.
Salix cf. *sphenophylla* A.K. Skvortsov
Salix commutata Bebb
Salix discolor Muhl.
Salix drummondiana Barratt ex Hook.
Salix glauca var. *acutifolia* (Hook.) C.K. Schneid.
Salix lasiandra Benth.
Salix maccalliana Rowlee
Salix nivalis Hook.
Salix petrophila Rydb.
Salix planifolia Pursh
Salix prolixa Andersson
Salix pseudomonticola C.R. Ball
Salix pseudomyrsinites Anderss.
Salix reticulata L.
Salix scouleriana Barratt ex Hook.
Salix sitchensis Sanson ex Bong.
Sambucus racemosa L.
Sanguisorba stipulata Raf.
Sanicula graveolens Poepp. ex DC.
Saxifraga adscendens L.
Saxifraga cespitosa L.
Saxifraga hyperborea R. Br.
Saxifraga mertensiana Bong.
Saxifraga oppositifolia ssp. *smalliana* (Engl. & Irmsch.) Hultén
Saxifraga tricuspidata Rottb.
Sedum divergens S. Watson
Selaginella wallacei Hieron.
Senecio lugens Richards.
Senecio triangularis Hook.
Shepherdia canadensis (L.) Nutt.
Sibbaldia procumbens L.
Silene acaulis (L.) Jacq.
Solidago multiradiata Aiton
Sorbus scopulina E. Greene
Sorbus sitchensis M. Roem.
Sparganium angustifolium Michx.
Sparganium natans L.
Stellaria borealis Bigelow var. *borealis*
Stellaria borealis ssp. *sitchana* (Steud.) Piper & Beattie
Stellaria calycantha (Ledeb.) Bong.
Stellaria crispa Cham. & Schltdl.
Stellaria monantha Hultén
Streptopus amplexifolius (L.) DC.
Streptopus lanceolatus var. *curvipes* (Vail) Reveal
Stuckenia sp.
Symphoricarpos albus (L.) S.F. Blake
Symphyotrichum foliaceum var. *apricum* (A.Gray) G.L.Nesom
Symphyotrichum foliaceum var. *foliaceum* (Lindl. ex DC.) G.L.Nesom
Taraxacum alaskanum Rydb.
Taraxacum ceratophorum (Ledeb.) DC. group
Taraxacum officinale F.H. Wigg.
Tellima grandiflora (Pursh) Douglas ex Lindl.
Tiarella trifoliata var. *trifoliata* L.
Tiarella trifoliata var. *unifoliata* (Hook.) Kurtz
Tofieldia pusilla (Michx.) Pers.
Trichophorum caespitosum (L.) Hartman
Trientalis arctica Fisch. ex Hook.
Trisetum canescens Buckley
Trisetum spicatum (L.) K. Richt.
Tsuga mertensiana (Bong.) Carrière
Vaccinium alaskaense J.R.Anderson
Vaccinium caespitosum Michx.
Vaccinium membranaceum Douglas ex Torr.
Vaccinium ovalifolium Sm.
Vaccinium uliginosum L.
Vaccinium vitis-idaea L.
Vahlodea atropurpurea (Wahlenb.) Fr. ex Hartm.
Valeriana sitchensis Bong.
Veratrum viride Aiton
Veronica beccabunga var. *americana* Rafinesque
Veronica serpyllifolia L.
Veronica wormskjoldii Roem. & Schult.
Viburnum edule (Michx.) Raf.
Viola adunca Sm.
Viola epipsila Ledeb.
Viola glabella Nutt.
Viola langsdorfii Fisch. ex Ging.
Viola orbiculata Geyer ex Holz.
Viola palustris L.
Woodsia alpina (Bolton) A. Gray
Woodsia ilvensis (L.) R. Br.
Woodsia scopulina D.C. Eaton

Appendix 8-3

Observed Plant and Lichen Species in each Survey Site in the 2012 – 2013 Rare Plant and Lichen Surveys

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Appendix 8-3. Observed Plant and Lichen Species in each Survey Site in the 2012 – 2013 Rare Plant and Lichen Surveys

July 12, 2012, Bowser Valley, along River Shores, Gravel Bars and Cliffs, Exploration Proposed Road

Abies lasiocarpa
Acarospora sinopica
Acer glabrum
Achillea millefolium var. alpinum
Achnatherum nelsonii
Alnus viridis ssp. sinuata
Amelanchier florida
Anaphalis margaritacea
Antennaria alpina
Antennaria media
Antennaria rosea ssp. confinis
Aquilegia formosa
Arabis eschscholtziana
Arctostaphylos uva-ursi
Arnica gracilis
Artemisia campestris
Artemisia michauxiana silvery form
Betula papyrifera
Boechera collinsii
Boechera divaricarpa
Boechera grahamii
Boechera macounii
Boechera retrofracta
Boechera stricta
Brachythecium albicans
Bucklandiella heterosticha
Campanula rotundifolia
Candelariella rosulans
Carex hoodii
Carex lenticularis limnophila
Carex rossii
Castilleja miniata
Castilleja unalaschensis
Cerastium arvense (green form)
Ceratodon purpureus
Cladina mitis
Cladina rangiferina
Cladina unknown (KC+ yellow, K+ yellow)
Cladonia borealis
Cladonia coccifera
Cladonia crispata ssp. crispata
Cladonia ecmocyna occidentalis
Cladonia gracilis elongata
Cladonia metacorallifera
Cladonia singularis
Cladonia stricta
Cladonia wainioi
Collema crispum
Collema cristatum var. marginale
Collema undulatum
Collinsia parviflora
Collomia linearis
Cornus stolonifera
Cryptogramma acrostichoides
Cystoperis firm erect non-glandular
Danthonia intermedia
Dermatocarpon intestiniforme
Dermatocarpon leptophyllodes
Dermatocarpon reticulatum
Diploschistes scruposus
Ditrichum flexicaule
Draba glabella
Draba praealta
Draba sp nov
Dryas drummondii
Drymocallis glandulosa
Elymus glaucus

Elymus trachy unawned (glaucous form)
Epilobium latifolium
Epilobium minutum
Equisetum arvense
Equisetum variegatum
Erigeron acris kamtchaticus
Erigeron compositus
Festuca saximontana
Gymnomitrion corallioides
Heuchera glabra
Hieracium albiflorum
Homalothecium aeneum
Hypogymnia occidentalis
Juniperus communis
Lecanora argopholis
Lecanora muralis
Lecanora polytropa
Lecanora reagens
Leciophysma furfuracascens?
Lempholemma cladodes
Lempholemma polyanthes
Leptogium pulvinatum
Lescurea baileyi
Lupinus nootkatensis
Maianthemum racemosum
Maianthemum stellatum
Massalongia carnosa
Melampyrum lineare
Neckera menziesii
Nephroma parile
Niphotrichum canescens
Onchophorus wahlenbergii
Oplopanax horridus
Orthilia secunda
Orthotrichum laevigatum
Osmorhiza berteroi
Packera indecora
Parmelia saxatilis
Parmeliella triptophylla
Parmeliopsis ambigua
Parmeliopsis hyperopta
Paxistima mysrinites
Peltigera collina
Peltigera lepidophora
Peltigera praetextata
Peltigera rufescens
Penstemon serrulatus
Phaeophyscia decolor
Philonotis fontana var. fontana
Physcia dubia
Physcia phaea
Physconia perisidiosa
Piperia unalascensis
Poa alpina
Poa arctica ssp. grayana
Poa glauca ssp. rupicola
Poa interior
Poa nemoralis
Poa scabrella
Pohlia cruda
Polychidium muscicola
Polygonum minimum
Polygonum sawatchense
Polypodium hesperium
Polystichum lonchitis
Polytrichum juniperinum
Populus balsamifera
Populus tremuloides
Psora himalayana
Pyrola asarifolia
Radula complanata
Rhizocarpon geminatum
Rhizocarpon geographicum
Rhizocarpon grande
Rhizocarpon ridescens
Ribes lacustre
Rubus idaeus
Rubus parviflorus
Salix barclayi
Salix barrattiana
Salix drummondiana
Salix scouleriana
Sambucus racemosa
Sanicula graveolens
Sanionia uncinata
Saxifraga tricuspidata

Schistidium frigidum
Sedum divergens
Selaginella wallacei
Shepherdia canadensis
Solidago multiradiata
Sorbus scopulina
Sorbus sitchensis
Stereocaulon tomentosum
Symphoricarpos albus
Trisetum spicatum
Vaccinium membranaceum
Vahliella leucophaea
Vestergrenopsis isidiata
Viola adunca
Woodsia scopulina
Xanthoria sorediata

July 13, 2012, Large Marsh at Bend in the Valley, turning into Scott Creek, near the Proposed Crushing Facility; Mineral Rich, including Ferric Material and Perhaps also High pH Minerals

Abies lasiocarpa
Alnus viridis ssp. sinuata
Aneura pinguis
Aulacomnium palustre
Barbilophozia hatcheri
Buellia penichra
Carex aquatilis var. aquatilis
Carex garberi
Carex rostrata x utriculata
Carex sitchensis
Comarum palustre
Cornus stolonifera
Cratoneuron filicinum
Drepanocladus aduncus
Epilobium ciliatum ssp. ciliatum
Epilobium ciliatum ssp. glandulosum
Epilobium davuricum
Epilobium palustre
Equisetum arvense
Equisetum fluviatile
Equisetum variegatum
Eriophorum angustifolium
Helodium blandowii
Helodium paludosum
Heracleum lanatum
Juncus arcticus ssp. sitchensis
Lecanora fuscescens
Lecanora pulicaris
Listera cordata
Marchantia polymorpha
Meesia uliginosa
Orthilia secunda
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia kotzebuei
Philonotis fontana var. fontana
Plagiomnium ellipticum
Platanthera dilitata var. dilitata
Pohlia nutans
Pohlia wahlenbergii
Populus balsamifera
Pyrola minor
Salix alaxensis ssp. longistylis
Salix barclayi
Salix barrattiana
Salix commutata
Salix drummondiana
Salix glauca ssp. acutifolia
Salix lasiandra
Salix planifolia
Salix prolixa
Salix pseudomyrsinites
Salix sitchensis
Sarmentypnum exannulatum
Shepherdia canadensis
Stellaria borealis
Tomentypnum falcifolium
Tomentypnum nitens
Vaccinium membranaceum
Vaccinium ovalifolium

July 13, 2012, Near Intersection of Glaciers, around 439724 6254035

Abies lasiocarpa
Agoseris aurantiaca
Alnus viridis ssp. sinuata
Anaphalis margaritacea
Andreaea blyttii
Antennaria umbrinella
Arnica latifolia
Asterella gracilis group
Athyrium americanum
Baeomyces rufus
Botrychium lunaria
Botrychium minganense
Brachythecium acutum
Bryocaulon hyperboreum
Bucklandiella heterosticha
Cassiope mertensiana
Castilleja miniata
Ceratodon purpureus
Cirsium edule
Cladonia amaurocraea
Cladonia pseudalcicornis
Collema fuscovirens
Conostomum tetragonum
Cryptogramma acrostichoides
Dicranoweisia crispula
Dicranum pallidisetum
Didymodon rigidulus var. rigidulus
Ditrichum flexicaule
Drepanocladus aduncus
Dryas drummondii
Epilobium anagallidifolium
Epilobium clavatum
Epilobium lactiflorum
Epilobium latifolium
Equisetum variegatum
Erigeron nivalis
Eriophorum angustifolium
Gentianella propinqua
Gymnocarpium dryopteris
Hieracium albiflorum
Imbribryum sp. unknown
Juncus drummondii
Lepraria alpina
Lescurea baileyi
Luzula parviflora
Luzula spicata
Niphotrichum canescens
Niphotrichum ericoides
Niphotrichum muticum
Niphotrichum pygmaeum
Orthilia secunda
Parnassia kotzebuei
Peltigera conspersa
Peltigera polydactylon
Peltigera ponojensis
Philonotis fontana var. fontana
Phleum alpinum
Phyllodoce glanduliflora
Poa alpina
Poa arctica ssp. grayana
Poa cusickii ssp. epilis
Poa paucispicula? (see specimen)
Pohlia cruda
Pohlia nutans
Polystichum lonchitis
Polytrichum juniperinum
Populus balsamifera
Protopannaria pezizoides
Pseudoleskea atricha
Racomitrium lanuginosum
Sagina saginoides
Salix arctica
Salix barrattiana
Salix cf sphenophylla
Salix commutata
Salix drummondiana
Salix nivalis
Saxifraga tricuspidata
Schistidium cf. atrichum
Schistidium rivulare
Sciurohypnum populeum
Shepherdia canadensis

Solorina crocea
Stellaria borealis
Stereocaulon alpinum
Stereocaulon rivulorum
Stereocaulon tomentosum
Trisetum spicatum
Tsuga mertensiana
Valeriana sitchensis
Xanthoria sorediata

July 14, 2012, North Side of Knipple Lake on West Side of Inlet around Old Road

Abies lasiocarpa
Acarospora sinopica
Actaea rubra
Agoseris aurantiaca
Agrostis mertensii
Alnus viridis ssp. sinuata
Anaphalis margaritacea
Andreaea blyttii
Arctostaphylos uva-ursi
Aruncus dioicus
Asterella gracilis group
Athyrium americanum
Athyrium filix-femina
Boechera retrofracta
Bromus ciliatus
Bromus vulgaris
Bucklandiella sudetica
Calamagrostis canadensis
Carex garberi
Carex illota
Carex lenticularis limnophila
Carex macloviana
Carex mertensii
Carex rostrata x utriculata
Carex tahoensis
Castilleja miniata
Cephaloziella divaricata var. divaricata
Ceratodon purpureus
Cladonia bellidiflora
Cladonia borealis
Cladonia pyxidata
Cryptogramma acrostichoides
Cystoperis firm erect non-glandular
Cystopteris fragilis normal form
Dichodontium pellucidum
Dicranoweisia crispula
Ditrichum flexicaule
Dryas drummondii
Dryptodon patens
Elymus glaucus
Epilobium angustifolium
Epilobium ciliatum ssp. ciliatum
Epilobium ciliatum ssp. glandulosum
Epilobium lactiflorum
Epilobium latifolium
Equisetum arvense
Galium triflorum
Geum macrophyllum
Hieracium albiflorum
Hierochloe alpina
Isopterygiopsis pulchella
Juncus drummondii
Juniperus communis
Lepraria alpina
Massalongia carnosa
Micranthes occidentalis
Mielichhoferia elongata
Mitella pentandra
Niphotrichum canescens
Niphotrichum muticum
Orthilia secunda
Osmorhiza berteroi
Peltigera leucophlebia
Peltigera ponojensis
Peltigera praetextata
Placopsis gelida
Placynthium nigrum
Poa alpina
Poa arctica ssp. grayana
Poa glauca ssp. rupicola

Podagrostis humilis
Polychidium muscicola
Polypodium hesperium
Polystichum lonchitis
Populus balsamifera
Protopannaria pezizoides
Ptychostomum pseudotriquetrum
Rhizocarpon geographicum
Ribes lacustre
Salix alaxensis ssp. longistylis
Salix arctica
Salix cf phlebophylla
Salix commutata
Salix drummondiana
Salix glauca ssp. acutifolia
Salix prolixa
Salix scouleriana
Sambucus racemosa
Saxifraga tricuspidata
Schistidium cf. atrichum
Shepherdia canadensis
Solidago multiradiata
Sorbus scopulina
Sparganium angustifolium
Sparganium natans? (immature)
Stereocaulon alpinum
Stereocaulon glareosum
Stereocaulon tomentosum
Tortella fragilis
Trisetum spicatum
Tsuga mertensiana
Vaccinium ovalifolium
Vestergrenopsis isidiata

July 14, 2012, Bowser Valley Old Road, River Shore and Cliffs

Abies lasiocarpa
Acarospora smaragdula
Acer glabrum
Achillea millefolium var. alpinum
Actaea rubra
Agoseris aurantiaca
Agrostis exarata
Agrostis scabra
Agyrium rufum
Alectoria sarmentosa
Alnus viridis ssp. sinuata
Amelanchier florida
Amphidium mougeotii
Amygdalaria panaeola
Anaphalis margaritacea
Andreaea rupestris
Anemone multifida
Aquilegia formosa
Arabidopsis lyrata ssp. kamchatica
Arabis eschscholtziana
Arctostaphylos uva-ursi
Arnica chamissonis foliosa
Arnica gracilis
Artemisia campestris
Artemisia michauxiana silvery form
Aruncus dioicus
Aspicilia contorta
Athyrium americanum
Athyrium filix-femina
Bacidina sp. A (sensu Spribille & Ekman)
Barbula convoluta
Betula papyrifera
Biatora oligocarpa
Bilimbia accedens
Boechera collinsii
Boechera divaricarpa
Boechera macounii
Boechera retrofracta
Brachytheciastrum velutinum
Brachythecium albicans
Bromus marginatus
Bryoria fuscescens
Bryoria glabra
Bryoria kockiana
Bucklandiella heterosticha
Buellia penichra
Calamagrostis canadensis
Caloplaca arenaria
Caloplaca jungermanniae
Campanula rotundifolia
Candelariella rosulans
Carex aurea
Carex hoodii
Carex lenticularis limnophila

Carex saxatilis
Castilleja miniata
Cerastium arvense (green form)
Ceratodon purpureus
Chimaphila umbellata
Cladina arbuscula
Cladina mitis
Cladina rangiferina
Cladonia amaurocraea
Cladonia borealis
Cladonia cyanipes
Cladonia ecmocyna occidentalis
Cladonia fimbriata
Cladonia gracilis elongata
Cladonia gracilis turbinata
Cladonia pyxidata
Cladonia singularis
Cladonia sp. 1 (sensu Goward 1999)
Cladonia uncialis
Clintonia uniflora
Collema crispum
Collema cristatum var. marginale
Collema curtisporum
Collema fuscovirens
Collema sp nov
Collema subflaccidum
Collinsia parviflora
Cornus canadensis
Cornus stolonifera
Cryptogramma acrostichoides
Cystoperis firm erect non-glandular
Cystopteris fragilis normal form
Dermatocarpon leptophyllodes
Dermatocarpon reticulatum
Dicranum scoparium
Didymodon fallax
Diploschistes scruposus
Distichum capillaceum
Ditrichum flexicaule
Ditrichum gracile
Draba glabella
Draba praealta
Dryas drummondii
Drymocallis glandulosa
Elymus glaucus
Elymus trachy unawned (glaucous form)
Encalypta rhapdocarpa
Encalypta vulgaris
Ephebe hispidula
Epilobium angustifolium
Epilobium clavatum
Epilobium hornemannii ssp. behringianum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron acris kamtchaticus
Erigeron compositus
Erigeron nivalis
Euopsis granatina
Euopsis pulvinata
Festuca occidentalis
Festuca saximontana
Fragaria vesca
Fuscopannaria cheiroloba
Fuscopannaria mediterranea
Goodyera oblongifolia
Grimmia torquata
Haematomma ochroleucum
Hedwigia ciliata
Heracleum lanatum
Heuchera glabra
Hieracium albiflorum
Homalothecium aeneum
Hylocomium splendens
Hypnum circinale
Hypogymnia apinnata
Hypogymnia occidentalis
Hypogymnia rugosa
Imbribryum gemmiparum?
Isopterygiopsis pulchella
Isothecium stoloniferum
Juncus arcticus ssp. sitchensis
Juncus ensifolius
Juncus mertensianus
Juniperus communis
Lecanora argopholis
Lecanora caesiosora
Lecanora cenisia
Lecanora marginalis
Lecanora reagens
Lecidea erythrophaea
Lecidea fuscoatra group
Lecidea hypnorum
Lecidea lapicida
Lempholemma intricatum
Lempholemma polyanthes
Lepraria vouauxii
Leptogium cyanescens
Leptogium intermedium (epiphytic form)
Leptogium saturninum

Leptogium teretiusculum
Lescurea baileyi
Lobaria hallii
Lobaria pulmonaria
Lobaria scrobiculata
Lophozia porphyrospoda
Lupinus nootkatensis
Maianthemum racemosum
Massalongia carnosa
Micranthes occidentalis
Mnium spinulosum
Moelleropsis nebulosa
Montanelia sorediata
Mycoblastus sanguinarius
Neckera menziesii
Nephroma bellum
Nephroma helveticum ssp. sipeanum
Nephroma parile
Niphotrichum canescens
Oplopanax horridus
Orthilia secunda
Orthotrichum speciosum
Osmorhiza berteroi
Packera indecora
Parmelia hygrophylla
Parmeliella triptophylla
Parmeliopsis ambigua
Parmeliopsis hyperopta
Paxistima mysrinites
Peltigera aphthosa
Peltigera collina
Peltigera conspersa
Peltigera lepidophora
Peltigera leucophlebia
Peltigera malacea
Peltigera membranacea
Peltigera neopolydactyla
Peltigera ponojensis
Peltigera praetextata
Peltigera rufescens
Peltigera scabrosa
Peltigera venosa
Penstemon serrulatus
Pertusaria alpina
Pertusaria ophthalmiza
Phaeophyscia decolor
Phaeophyscia sciastra
Phleum alpinum
Phlyctis argena
Phylliscum demangeonii
Physcia dubia
Physconia americana
Physconia enteroxantha
Piperia unalascensis
Placopsis gelida
Placynthiella uliginosa
Placynthium asperellum
Placynthium flabellosum
Placynthium nigrum
Plagiomnium medium
Platismatia glauca
Plectocarpon lichenum
Poa alpina
Poa arctica ssp. grayana
Pohlia cruda
Polypodium hesperium
Polystichum lonchitis
Polytrichum juniperinum
Populus balsamifera
Porella cordeana
Porpidia crustulata
Porpidia flavicunda
Potentilla arenosa
Potentilla arenosa x nivea
Potentilla hyparctica ssp. elatior
Potentilla rubricaulis
Pseudocyphellaria anomala
Pseudoleskea incurvata
Psora globifera
Psora himalayana
Psora tuckermanii
Psorula rufonigra
Ptilidium pulcherrimum
Ptilium crista-castrensis
Pyrola asarifolia
Radula complanata
Ramalina thrausta
Ramboldia cinnabarina
Ranunculus pensylvanicus
Rhizocarpon bolanderi
Rhizocarpon chioneum
Rhizocarpon disporum
Rhizocarpon grande
Rhytidiadelphus loreus
Rhytidiadelphus triquetrus
Rhytidiopsis robusta
Ribes hudsonianum
Ribes lacustre
Rubus idaeus
Rubus parviflorus

Salix discolor
Salix drummondiana
Salix scouleriana
Sambucus racemosa
Sanionia uncinata
Saxifraga tricuspidata
Schistidium agassizii
Schistidium apocarpum
Schistidium cf. atrichum
Schistidium rivulare
Sciurohypnum hylotapetum
Sedum divergens
Senecio triangularis
Shepherdia canadensis
Solidago multiradiata
Sorbus scopulina
Spilonema revertens
Staurothele areolata
Stereocaulon botryosum
Stereocaulon intermedium
Stereocaulon tomentosum
Strangospora moriformis
Streptopus amplexifolius
Symphoricarpos albus
Syntrichia princeps
Taraxacum officinale
Toninia ruginosa
Trisetum canescens
Trisetum spicatum
Tritomaria exectiformis
Umbilicaria hyperborea
Umbilicaria muhlenbergii
Vaccinium membranaceum
Vestergrenopsis isidiata
Viburnum edule
Viola adunca
Vulpicida pinastri
Woodsia scopulina
Xanthoria elegans
Xanthoria sorediata
Xylographa parallela

July 15, 2012, Alpine Ridge between Bowser Lake and Wildfire Camp, then Downslope toward Scott Creek, Starting Point 457994 6258550

Abies lasiocarpa
Acer glabrum
Aconitum delphiniifolium
Actaea rubra
Agoseris aurantiaca
Alectoria ochroleuca
Alectoria sarmentosa
Alnus viridis ssp. sinuata
Anemone richardsonii
Antennaria alpina
Antennaria monocephala ssp. monocephala
Antennaria rosea ssp. confinis
Arnica latifolia
Arnica mollis
Artemisia norvegica
Aruncus dioicus
Athyrium americanum
Athyrium filix-femina
Bartramia ithyphylla
Bistorta vivipara
Boechera stricta
Botrychium lunaria
Bryonora pruinosa
Calamagrostis purpurascens
Caloplaca jungermanniae
Caloplaca nivalis
Campanula lasiocarpa
Candelariella reflexa
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia
Cardamine umbellata
Carex atrata sensu stricto?
Carex macrochaeta
Carex micropoda
Carex nardina
Carex nigricans
Carex tahoensis
Cassiope mertensiana
Castilleja parviflora
Cetraria ericetorum ssp. ericetorum
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria nigricans

Cladina mitis
Cladina rangiferina
Cladonia bellidiflora
Cladonia borealis
Cladonia chlorophaea
Cladonia ecmocyna intermedia
Cladonia ecmocyna occidentalis
Cladonia gracilis elongata
Cladonia singularis
Cladonia uncialis
Cladonia wainioi
Coelocaulon aculeatum
Coelocaulon sp nov
Collema sp nov
Cryptogramma acrostichoides
Dactylina arctica
Dactylina ramulosa
Dicranoweisia crispula
Diphasiastrum alpinum
Draba glabella
Draba macounii
Draba ruaxes
Draba stenoloba
Elymus alaskanus
Empetrum nigrum
Encalypta affinis
Encalypta longicollis?
Epilobium anagallidifolium
Epilobium angustifolium
Epilobium clavatum
Epilobium hornemannii ssp. behringianum
Epilobium lactiflorum
Epilobium latifolium
Epilobium luteum
Equisetum arvense
Equisetum variegatum
Erigeron glacialis
Erigeron humilis
Festuca altaica
Festuca brachyphylla?
Flavocetraria cucullata
Flavocetraria nivalis
Gemmabryum subapiculatum?
Gentiana glauca
Geranium erianthum
Gowardia nigricans
Gymnocarpium dryopteris
Heracleum lanatum
Heuchera glabra
Juncus drummondii
Juncus mertensianus
Juniperus communis
Lecanora epibryon
Lecanora polytropa
Lecanora stenotropa
Lecidea laboriosa
Lepraria alpina
Leptarrhena pyrolifolia
Lobaria linita
Luetkea pectinata
Lupinus nootkatensis
Luzula parviflora
Luzula piperi
Luzula spicata
Luzula wahlenbergii
Melanelia hepatizon
Micranthes ferruginea
Micranthes nelsoniana var. porsildiana
Micranthes nivalis
Micranthes occidentalis
Mitella pentandra
Myosotis asiatica
Nephroma arcticum
Nephroma expallidum
Niphotrichum canescens
Niphotrichum ericoides
Niphotrichum pygmaeum
Ochrolechia bryophaga
Ochrolechia gyalectina
Ochrolechia inaequatula
Oplopanax horridus
Orthilia secunda
Osmorhiza berteroi
Oxyria digyna
Parmelia omphalodes
Parmeliopsis ambigua

Parmeliopsis hyperopta
Parnassia fimbriata
Peltigera aphthosa
Peltigera chionophila
Peltigera malacea
Peltigera occidentalis
Peltigera ponojensis
Peltigera praetextata
Peltigera scabrosa
Peltigera scabrosella?
Peltigera venosa
Pertusaria dactylina
Pertusaria geminipara
Pertusaria oculata
Pertusaria suboculata
Petasites nivalis
Philonotis fontana var. fontana
Phleum alpinum
Phyllodoce glanduliflora
Platanthera stricta
Poa abbreviata?
Poa cusickii ssp. epilis
Poa cusickii ssp. pallida
Poa paucispicula? (see specimen)
Pohlia cruda
Polemonium elegans
Polytrichum piliferum
Populus balsamifera
Potentilla concinna? (odd)
Potentilla glaucophylla
Potentilla hyparctica ssp. elatior
Potentilla nana
Potentilla villosula
Protopannaria pezizoides
Protoparmelia badia
Pseudoleskea atricha
Psoroma hypnorum
Ptychostomum pendulum
Ptychostomum pseudotriquetrum
Racomitrium lanuginosum
Ranunculus eschscholtzii
Ranunculus nivalis
Rhizocarpon lecanorinum
Rhytidium rugosum
Ribes lacustre
Rinodina mniaraea var. cinnamomea
Rinodina mniaraea var. mniaraea
Rinodina olivaceobrunnea
Rinodina terrestris
Roellia roellii
Rubus idaeus
Rubus parviflorus
Rubus pedatus
Rubus spectabilis
Rumex lapponicus
Salix commutata
Salix nivalis
Sambucus racemosa
Sanguisorba stipulata
Sanionia uncinata
Saxifraga mertensiana
Saxifraga tricuspidata
Sedum divergens
Selaginella wallacei
Senecio lugens
Senecio triangularis
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Solorina crocea
Sorbus scopulina
Sorbus sitchensis
Stellaria monantha
Stereocaulon alpinum
Stereocaulon arcticum?
Stereocaulon cf uliginosum
Stereocaulon glareosum
Stereocaulon nivale
Stereocaulon paschale
Stereocaulon rivulorum
Stereocaulon tomentosum
Streptopus amplexifolius
Symphyotrichum foliaceum
Taraxacum alaskanum
Taraxacum ceratophorum group
Thamnolia vermicularis

Tiarella unifoliata
Trapeliopsis granulosa
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Umbilicaria cylindrica
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria torrefacta
Vaccinium membranaceum
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Viola glabella
Viola langsdorfii
Viola orbiculata
Vulpicida pinastri
Xanthoria sorediata

July 16, 2012, Alpine Area shortly Northwest Upslope from Brucejack Lake

Abies lasiocarpa
Achillea millefolium var. alpinum
Aconitum delphiniifolium
Agoseris aurantiaca
Alectoria ochroleuca
Alectoria sarmentosa
Amygdalaria panaeola
Anastrophyllum (reddish)
Andreaea rupestris
Anemone parviflora
Aneura pinguis
Antennaria alpina
Antennaria monocephala ssp. angustata
Anthelia juratzkana
Arabidopsis lyrata ssp. kamchatica
Arnica latifolia
Arnica mollis
Artemisia norvegica
Arthrorhaphis alpina
Arthrorhaphis citrinella
Aspicilia verrucosa
Aulacomnium palustre
Barbilophozia hatcheri
Bartramia ithyphylla
Bellemerea subsorediza
Biatora cuprea
Bilimbia sabuletorum
Bistorta vivipara
Botrychium lunaria
Brachythecium albicans
Brachythecium frigidum
Bryocaulon divergens
Bryocaulon hyperboreum
Bryonora pruinosa
Bryoria fremontii
Bucklandiella affinis?
Bucklandiella sudetica
Calamagrostis purpurascens
Caltha biflora
Campanula lasiocarpa
Candelariella rosulans
Cardamine bellidifolia
Cardamine umbellata
Carex atrata sensu stricto?
Carex micropoda
Carex nardina
Carex nigricans
Carex scirpoidea var. scirpoidea
Carex spectabilis? (immature)
Cassiope mertensiana
Cassiope tetragona
Castilleja miniata
Castilleja parviflora
Catapyrenium cinereum
Catapyrenium daedaleum
Cephalozia connivens
Cerastium arvense (green form)
Cetraria delisei
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria nigricans
Cladina arbuscula
Cladina cf portentosa (branching in 2's)
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia amaurocraea
Cladonia bellidiflora
Cladonia borealis
Cladonia coccifera
Cladonia crispata ssp. cetrariiformis
Cladonia ecmocyna occidentalis
Cladonia gracilis elongata

Cladonia pocillum
Cladonia pyxidata
Cladonia singularis
Cladonia subfurcata
Cladonia uncialis
Cladonia wainioi
Coelocaulon aculeatum
Collema callopismum var. callopismum
Collema glebulentum
Conostomum tetragonum
Dactylina arctica
Dermatocarpon rivulorum
Dicranoweisia crispula
Didymodon rigidulus var. icmadophilus
Diphasiastrum alpinum
Diphasiastrum sitchense
Draba glabella
Draba macounii
Draba nivalis
Draba praealta
Draba sp nov
Dryas integrifolia
Empetrum nigrum
Encalypta rhapdocarpa
Epilobium angustifolium
Epilobium clavatum
Epilobium lactiflorum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron humilis
Erigeron peregrinus
Festuca altaica
Flavocetraria cucullata
Flavocetraria nivalis
Fuscopannaria praetermissa
Gentiana glauca
Geranium erianthum
Gowardia nigricans
Gymnomitrion corallioides
Harrimanella stelleriana
Hierochloe alpina
Huperzia arctica
Huperzia haleakalae
Hylocomium splendens
Ionaspis odora
Jungermannia eucordifolia
Juniperus communis
Koerberiella wimmeriana
Lecanora argopholis
Lecanora bicincta
Lecanora epibryon
Lecanora polytropa
Lecidea beringeriana group (subsquamulose)
Lecidea lapicida
Lecidoma demissum
Lempholemma intricatum
Lempholemma polyanthes
Lepraria alpina
Leptarrhena pyrolifolia
Leptogium imbricatum
Lloydia serotina var. serotina
Lobaria linita
Loeskypnum badium
Luetkea pectinata
Lupinus nootkatensis
Luzula arcuata
Luzula parviflora
Luzula spicata
Luzula wahlenbergii
Lycopodium annotinum ssp. pungens
Massalongia carnosa
Melanelia hepatizon
Micranthes ferruginea
Micranthes lyallii
Micranthes nelsoniana var. porsildiana
Micranthes occidentalis
Micranthes tenuis
Minuartia biflora
Montanelia sorediata
Myosotis asiatica
Nephroma arcticum
Niphotrichum ericoides
Nodobryoria subdivergens (sulcate)
Ochrolechia bryophaga
Ochrolechia frigida
Ochrolechia grimmiae
Ochrolechia gyalectina
Ophioparma ventosa
Orthilia secunda
Parmelia omphalodes
Parnassia fimbriata
Pedicularis sudetica
Peltigera chionophila
Peltigera lepidophora
Peltigera malacea
Peltigera praetextata
Pertusaria dactylina
Pertusaria geminipara
Pertusaria subdactylina

Petasites nivalis
Phaeophyscia cf. nigricans (minute, ciliate, brown, fertile, non-isid/sored)
Phaeophyscia decolor
Philonotis fontana var. fontana
Phleum alpinum
Phyllodoce glanduliflora
Placopsis gelida
Placynthium asperellum
Placynthium flabellosum
Placynthium nigrum
Pleurozium schreberi
Poa alpina
Poa cusickii ssp. epilis
Poa pratensis ssp. colpodea
Pohlia cruda
Polyblastia sendtneri
Polytrichum piliferum
Porpidia flavicunda
Potentilla glaucophylla
Potentilla nana
Preissia quadrata
Protopannaria pezizoides
Pseudephebe minuscula
Pseudephebe pubescens
Psora himalayana
Psoroma hypnorum
Racomitrium lanuginosum
Ranunculus eschscholtzii
Ranunculus pygmaeus
Rhizocarpon atroflavescens
Rhizocarpon chioneum
Rhizocarpon lecanorinum
Rhizocarpon oederi
Rhizomnium pseudopunctatum
Rhodiola integrifolia
Rinodina mniaraea var. cinnamomea
Rubus arcticus
Salix commutata
Salix nivalis
Salix prolixa
Salix reticulata
Sanguisorba stipulata
Sanionia orthothecioides
Saxifraga caespitosa
Saxifraga mertensiana
Saxifraga oppositifolia ssp. smalliana
Saxifraga tricuspidata
Scapania uliginosa
Schistidium cf. atrichum
Schistidium frigidum
Senecio triangularis
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Solorina bispora
Solorina crocea
Solorina octospora
Sphaerophorus fragilis
Sphaerophorus globosus
Sphagnum subnitens
Spilonema revertens
Stellaria monantha
Stereocaulon alpinum
Stereocaulon arcticum?
Stereocaulon botryosum
Stereocaulon klondikense
Stereocaulon paschale
Stereocaulon rivulorum
Stereocaulon symphycheilum
Stereocaulon tomentosum
Stereocaulon vesuvianum
Syntrichia ruralis
Taraxacum alaskanum
Tephromela atra
Tetralophozia setiformis
Thamnolia vermicularis
Tofieldia pusilla
Tortella tortuosa var. tortuosa
Trapeliopsis granulosa
Trisetum spicatum
Umbilicaria arctica?
Umbilicaria cylindrica
Umbilicaria deusta
Umbilicaria havaasii
Umbilicaria hyperborea
Umbilicaria lambii
Umbilicaria proboscidea
Umbilicaria torrefacta
Vaccinium uliginosum
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Vestergrenopsis elaeina
Vestergrenopsis isidiata
Viola epipsila
Viola langsdorfii
Woodsia alpina
Woodsia ilvensis
Xanthoria elegans

Xanthoria sorediata

July 16, 2012, Alpine Area from "Orange Toque" Westward along Ridge and Downslope to South

Abies lasiocarpa
Acarospora sinopica
Achillea millefolium var. alpinum
Aconitum delphiniifolium
Agoseris aurantiaca
Alectoria ochroleuca
Alnus viridis ssp. sinuata
Amphidium lapponicum
Amygdalaria panaeola
Anemone parviflora
Anemone richardsonii
Antennaria alpina
Antennaria monocephala ssp. angustata
Aquilegia formosa
Arabidopsis lyrata ssp. kamchatica
Arnica mollis
Artemisia norvegica
Arthrorhaphis alpina
Aulacomnium palustre
Barbilophozia floerkii
Bistorta vivipara
Calamagrostis canadensis
Campanula lasiocarpa
Candelariella vitellina
Cardamine bellidifolia
Cardamine umbellata
Carex atrata sensu stricto?
Carex macrochaeta
Carex micropoda
Carex nardina
Carex nigricans
Carex saxatilis
Cassiope mertensiana
Cassiope tetragona
Catapyrenium cinereum
Catillaria (unknown species)
Cerastium arvense (green form)
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria nigricans
Cladina arbuscula
Cladina rangiferina
Cladina stellaris
Cladonia amaurocraea
Cladonia bellidiflora
Cladonia borealis
Cladonia crispata ssp. cetrariiformis
Cladonia ecmocyna occidentalis
Cladonia gracilis elongata
Cladonia pyxidata
Cladonia uncialis
Coelocaulon aculeatum
Coelocaulon sp nov
Collema ceraniscum
Conostomum tetragonum
Dactylina arctica
Diphasiastrum alpinum
Draba glabella
Draba nivalis
Draba stenoloba
Dryas integrifolia
Empetrum nigrum
Encalypta affinis
Epilobium clavatum
Epilobium hornemannii ssp. behringianum
Epilobium hornemannii ssp. hornemannii
Epilobium lactiflorum
Equisetum arvense
Equisetum variegatum
Erigeron humilis
Festuca altaica
Festuca brachyphylla?
Flavocetraria cucullata
Flavocetraria nivalis
Gentiana glauca
Geranium erianthum
Gymnomitrion corallioides
Harrimanella stelleriana
Hieracium triste (non-glandular)
Hierochloe alpina
Huperzia arctica
Hylocomium splendens
Hypnum bambergeri
Ionaspis lacustris
Ionaspis odora
Juncus drummondii

Kobresia simpliciuscula
Lecanora polytropa
Lecidoma demissum
Lempholemma intricatum
Lepraria alpina
Leptarrhena pyrolifolia
Leptogium gelatinosum
Lloydia serotina var. serotina
Lobaria linita
Luetkea pectinata
Lupinus nootkatensis
Luzula spicata
Luzula wahlenbergii
Marsupella brevissima
Melanelia hepatizon
Micarea turfosa
Micranthes ferruginea
Micranthes nivalis
Micranthes tenuis
Minuartia rubella
Myosotis asiatica
Nephroma arcticum
Nephroma parile
Niphotrichum ericoides
Ochrolechia frigida
Parmelia omphalodes
Parmelia skultii
Parnassia fimbriata
Pedicularis sudetica
Pellia neesiana
Peltigera chionophila
Peltigera malacea
Pertusaria geminipara
Pertusaria oculata
Petasites nivalis
Phaeophyscia decolor
Placidium lachneum
Placidium lacinulatum var. atrans
Placynthium asperellum
Poa alpina
Poa arctica ssp. arctica
Poa arctica ssp. grayana
Pohlia nutans
Polyblastia cucurbitula
Polyblastia melaspora
Polytrichum piliferum
Porpidia contraponenda
Porpidia lowiana
Potentilla glaucophylla
Potentilla nana
Protopannaria pezizoides
Protoparmelia badia
Pseudephebe pubescens
Psora decipiens
Psora himalayana
Psoroma hypnorum
Ptychostomum pallescens
Racomitrium lanuginosum
Ranunculus pygmaeus
Rhizocarpon atroflavescens
Rhodiola integrifolia
Rhytidium rugosum
Rinodina mniaraea var. mniaraea
Salix arctica
Salix nivalis
Salix reticulata
Saxifraga caespitosa
Saxifraga oppositifolia ssp. smalliana
Saxifraga tricuspidata
Scapania uliginosa
Schistidium frigidum
Schistochilopsis incisa var. opacifolia
Selaginella wallacei
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Solorina bispora
Solorina crocea
Sphaerophorus fragilis
Sphaerophorus globosus
Stellaria monantha
Stereocaulon alpinum
Stereocaulon botryosum
Stereocaulon depressum
Stereocaulon glareosum
Stereocaulon klondikense
Stereocaulon rivulorum
Stereocaulon vesuvianum
Taraxacum alaskanum
Thamnolia vermicularis
Tortella tortuosa var. tortuosa
Trientalis arctica
Trisetum spicatum
Tsuga mertensiana
Umbilicaria cylindrica

Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria proboscidea
Umbilicaria torrefacta
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Verrucaria margacea
Vestergrenopsis isidiata
Viola epipsila
Viola langsdorfii
Xanthoria candelaria

July 17, 2012, Gravel Bar near Inlet to Bowser Lake

Abies lasiocarpa
Achillea millefolium var. alpinum
Alnus viridis ssp. sinuata
Amelanchier florida
Anaphalis margaritacea
Anemone multifida
Boechera retrofracta
Brachythecium albicans
Brachythecium salebrosum
Carex aurea
Carex lenticularis limnophila
Castilleja miniata
Castilleja unalaschensis
Ceratodon purpureus
Cladonia borealis
Cladonia cariosa
Cladonia cenotea
Cladonia cervicornis
Cladonia chlorophaea
Cladonia crispata ssp. cetrariiformis
Cladonia ecmocyna occidentalis
Cladonia gracilis turbinata
Cladonia macilenta
Cladonia sulphurina
Cladonia umbricola
Cryptogramma acrostichoides
Dryas drummondii
Elymus glaucus
Elymus trachy unawned (glaucous form)
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron acris kamtchaticus
Festuca occidentalis
Hieracium albiflorum
Hylocomium splendens
Juncus arcticus ssp. sitchensis
Lupinus nootkatensis
Marchantia polymorpha
Niphotrichum canescens
Orthilia secunda
Parmeliopsis ambigua
Parmeliopsis hyperopta
Peltigera aphthosa
Peltigera canina
Peltigera cf retifoveata
Peltigera ponojensis
Peltigera praetextata
Peltigera rufescens
Piperia unalascensis
Placynthiella uliginosa
Poa alpina
Poa arctica ssp. grayana
Polytrichum juniperinum
Populus balsamifera
Ptilidium pulcherrimum
Salix alaxensis ssp. alaxensis
Salix alaxensis ssp. longistylis
Salix commutata
Salix discolor
Salix drummondiana
Sanionia uncinata
Shepherdia canadensis
Solidago multiradiata
Stereocaulon tomentosum
Trisetum spicatum
Xylographa parallela

July 17, 2012, Snow Road from near Knipple Glacier toward Knipple Lake

Abies lasiocarpa
Acarospora sinopica
Achillea millefolium var. alpinum
Agoseris aurantiaca
Agrostis scabra
Alnus viridis ssp. sinuata

Anaphalis margaritacea
Aquilegia formosa
Arabidopsis lyrata ssp. kamchatica
Arnica mollis
Artemisia michauxiana silvery form
Aruncus dioicus
Athyrium americanum
Athyrium filix-femina
Calamagrostis canadensis
Cardamine umbellata
Carex hoodii
Carex mertensii
Carex scirpoidea var. scirpoidea
Castilleja miniata
Castilleja parviflora
Cerastium arvense (green form)
Cladonia borealis
Cryptogramma acrostichoides
Dichodontium pellucidum
Dryas drummondii
Epilobium clavatum
Epilobium lactiflorum
Epilobium latifolium
Equisetum arvense
Equisetum fluviatile
Gymnocarpium dryopteris
Heracleum lanatum
Heuchera glabra
Huperzia haleakalae
Juncus drummondii
Juncus mertensianus
Lecidea lapicida
Leptarrhena pyrolifolia
Luzula parviflora
Luzula wahlenbergii
Micranthes ferruginea
Micranthes lyallii
Micranthes nelsoniana var. porsildiana
Micranthes occidentalis
Mitella pentandra
Niphotrichum canescens
Orthilia secunda
Osmorhiza purpurea
Parnassia fimbriata
Penstemon serrulatus
Philonotis fontana var. fontana
Phleum alpinum
Poa alpina
Poa arctica ssp. grayana
Poa glauca ssp. rupicola
Polystichum lonchitis
Populus balsamifera
Prunella vulgaris
Ranunculus eschscholtzii
Ranunculus pygmaeus
Rubus parviflorus
Rubus spectabilis
Salix alaxensis ssp. longistylis
Salix arctica
Salix commutata
Salix drummondiana
Sanguisorba stipulata
Saxifraga tricuspidata
Sedum divergens
Stellaria crispa
Stereocaulon tomentosum
Streptopus amplexifolius
Symphyotrichum foliaceum
Tellima grandiflora
Valeriana sitchensis
Veratrum viride
Veronica serpyllifolia
Veronica wormskjoldii
Viola glabella
Viola orbiculata

July 17, 2012, Wetlands on Plateau between Wildfire Camp and Scott Creek

Abies lasiocarpa
Aconitum delphiniifolium
Alectoria sarmentosa
Alnus viridis ssp. sinuata

Anemone richardsonii
Aulacomnium palustre
Barbilophozia floerkii
Barbilophozia hatcheri
Biatora flavopunctata
Biatora meiocarpa
Biatora subduplex
Biatora vacciniicola
Blepharostoma trichophyllum
Bryoria fuscescens
Bryoria glabra
Buellia penichra
Calamagrostis canadensis
Calicium viride
Caltha biflora
Carex nigricans
Carex pauciflora? (only immature individuals seen)
Carex sitchensis
Cassiope mertensiana
Cetraria subalpina
Chiloscyphus polyanthos
Cladina cf portentosa (branching in 2's)
Cladonia bellidiflora
Cladonia coniocrea
Cladonia crispata ssp. cetrariiformis
Cladonia deformis
Cladonia digitata
Cladonia metacorallifera
Cladonia sulphurina
Cladonia transcendens
Cladonia umbricola
Comarum palustre
Cyphelium inquinans
Dicranum fuscescens
Dicranum pallidisetum
Drepanocladus aduncus
Epilobium angustifolium
Epilobium clavatum
Epilobium hornemannii ssp. hornemannii
Equisetum arvense
Erigeron peregrinus
Eriophorum angustifolium
Gemmabryum dichotomum
Gymnocarpium dryopteris
Harpanthus flotowianus
Hippuris montana
Huperzia chinensis
Huperzia occidentalis
Hypogymnia occidentalis
Hypogymnia rugosa
Hypogymnia wilfiana
Icmadophila ericetorum
Imshaugia aleurites
Kalmia microphylla
Lecanora pulicaris
Lecidea albohyalina
Lecidea porphyrospoda
Leptarrhena pyrolifolia
Lescurea baileyi
Listera cordata
Lobaria linita
Luetkea pectinata
Luzula parviflora
Micarea tenebrosa ined.
Micranthes nelsoniana var. nov
Mitella pentandra
Mnium spinulosum
Mycoblastus sanguinarius
Mycocalicium subtile
Myochroidea rufofusca
Nephroma arcticum
Nephroma parile
Osmorhiza purpurea
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia fimbriata
Pellia neesiana
Peltigera aphthosa
Peltigera chionophila
Peltigera membranacea
Peltigera neopolydactyla
Peltigera occidentalis
Peltigera praetextata
Pertusaria carneopallida
Pertusaria mccroreyae

Petasites nivalis
Platanthera dilitata var. dilitata
Platanthera stricta
Platismatia glauca
Pleurozium schreberi
Polytrichum strictum
Psoroma hypnorum
Ptilidium californicum
Ptilidium pulcherrimum
Ramboldia cinnabarina
Ranunculus eschscholtzii
Rhizomnium nudum
Rhytidiopsis robusta
Ribes laxiflorum
Roellia roellii
Rubus arcticus
Rubus pedatus
Rubus spectabilis
Salix barrattiana
Salix commutata
Salix glauca ssp. acutifolia
Salix sitchensis
Sanguisorba stipulata
Schistochilopsis incisa var. incisa
Sciurohypnum hylotapetum
Sciurohypnum populeum
Scorpidium revolvens
Senecio triangularis
Sorbus sitchensis
Sparganium angustifolium
Sphagnum capillifolium
Sphagnum pacificum
Sphagnum subnitens
Sphagnum teres
Streptopus amplexifolius
Streptopus lanceolatus
Symphyotrichum foliaceum
Tiarella unifoliata
Trientalis arctica
Tritomaria quinquedentata
Tsuga mertensiana
Vaccinium membranaceum
Vaccinium ovalifolium
Valeriana sitchensis
Varicellaria rhodocarpa
Veratrum viride
Viola epipsila

August 31, 2012, Vicinity of Brucejack Camp, around the West Side of Brucejack Lake, then Westward

Abies lasiocarpa
Aconitum delphiniifolium
Agoseris aurantiaca
Alectoria ochroleuca
Allantoparmelia almquistii
Allantoparmelia alpicola
Amygdalaria consentiens
Amygdalaria panaeola
Anaphalis margaritacea
Andreaea blyttii
Andreaea rupestris
Anemone parviflora
Antennaria alpina
Antennaria media
Antennaria monocephala ssp. monocephala
Antennaria rosea ssp. confinis
Anthelia julacea
Anthelia juratzkana
Arabidopsis lyrata ssp. kamchatica
Arctoparmelia incurva
Arnica gracilis
Arnica mollis
Artemisia norvegica
Aspicilia verrucosa
Asterella gracilis group
Athyrium americanum
Atrichum tenellum
Aulacomnium palustre
Barbilophozia floerkii
Bellemerea subsorediza

Belonia russula
Bistorta vivipara
Botrychium minganense
Brachythecium frigidum
Brodoa oroarctica
Bryocaulon divergens
Bryocaulon hyperboreum
Bryoria tenuis
Bucklandiella heterosticha
Bucklandiella sudetica
Calamagrostis canadensis
Caloplaca jungermanniae
Caltha biflora
Calypogeia muelleriana
Calypogeia sphagnicola
Campanula lasiocarpa
Cardamine bellidifolia
Cardamine umbellata
Carex albonigra
Carex atrata sensu stricto?
Carex brunnescens
Carex cf micropoda (but large and floppy)
Carex lachenalii
Carex macrochaeta
Carex micropoda
Carex nardina
Carex nigricans
Carex scirpoidea var. scirpoidea
Carex stylosa
Carex tahoensis
Cassiope mertensiana
Castilleja parviflora
Catapyrenium cinereum
Catapyrenium daedaleum
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria nigricans
Cetraria subalpina
Cladina arbuscula
Cladina cf portentosa (branching in 2's)
Cladina mitis
Cladina stellaris
Cladina stygia
Cladonia bellidiflora
Cladonia borealis
Cladonia carneola
Cladonia cf macroceras
Cladonia chlorophaea
Cladonia crispata ssp. cetrariiformis
Cladonia ecmocyna intermedia
Cladonia ecmocyna occidentalis
Cladonia maxima?
Cladonia metacorallifera
Cladonia pseudalcicornis
Cladonia squamosa
Cladonia subfurcata
Cladonia uncialis
Cladonia wainioi
Conostomum tetragonum
Cryptogramma acrostichoides
Cynodontium tenellum
Cystopteris fragilis normal form
Dermatocarpon rivulorum
Dibaeis baeomyces? (sterile crust only)
Dicranella palustris
Dicranum brevifolium
Diphasiastrum alpinum
Diphasiastrum sitchense
Draba crassifolia
Draba macounii
Draba nivalis
Draba praealta
Draba sp nov
Drepanocladus aduncus
Dryas integrifolia
Empetrum nigrum
Epilobium anagallidifolium
Epilobium angustifolium
Epilobium clavatum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron compositus
Erigeron humilis
Eriophorum angustifolium
Festuca altaica

Festuca cf baffinensis
Festuca groenlandica?
Festuca saximontana
Flavocetraria cucullata
Flavocetraria nivalis
Frutidella caesioatra
Gentiana glauca
Geranium erianthum
Gymnocolea inflata
Gymnomitrion concinnatum
Gymnomitrion corallioides
Gymnomitrion pacificum
Harrimanella stelleriana
Hieracium triste (non-glandular)
Hierochloe alpina
Hippuris montana
Huperzia arctica
Ionaspis odora
Juncus drummondii
Juncus mertensianus
Jungermannia borealis
Jungermannia exsertifolia
Juniperus communis
Kiaeria falcata
Kiaeria starkei
Koerberiella wimmeriana
Lecanora marginalis
Lecanora polytropa
Lecidea beringeriana group (subsquamulose)
Lecidella wulfenii
Lempholemma intricatum
Lepraria alpina
Leptarrhena pyrolifolia
Lloydia serotina var. serotina
Lobaria linita
Lopadium pezizoideum
Luetkea pectinata
Lupinus nootkatensis
Luzula arcuata
Luzula parviflora
Luzula piperi
Luzula spicata
Lycopodium annotinum ssp. pungens
Marsupella brevissima
Marsupella sphacellata
Melanelia hepatizon
Micranthes ferruginea
Micranthes lyallii
Micranthes nivalis
Micranthes tolmiei
Minuartia obtusiloba
Mitella pentandra
Mnium blyttii
Moerckia hibernica
Myosotis asiatica
Nephroma arcticum
Niphotrichum canescens
Niphotrichum muticum
Ophioparma ventosa
Oxyria digyna
Parmelia omphalodes
Parmeliopsis hyperopta
Parnassia fimbriata
Pellia neesiana
Peltigera chionophila
Peltigera conspersa
Peltigera lyngei?
Peltigera malacea
Peltigera scabrosa
Pertusaria dactylina
Pertusaria oculata
Pertusaria panyrga
Pertusaria subdactylina
Pertusaria suboculata
Petasites nivalis
Philonotis fontana var. fontana
Phleum alpinum
Phyllodoce glanduliflora
Placynthium nigrum
Pleurocladula albescens
Pleurozium schreberi
Poa alpina
Poa arctica ssp. arctica
Poa arctica ssp. grayana
Poa paucispicula? (see specimen)
Pohlia cardotii

Pohlia cruda
Pohlia drummondii
Pohlia wahlenbergii
Polystichum lonchitis
Polytrichum juniperinum
Polytrichum strictum
Porpidia (unknown species, umbonate apothecia)
Porpidia flavicunda
Porpidia melinodes
Porpidia thomsonii
Potentilla glaucophylla
Potentilla nana
Preissia quadrata
Protopannaria pezizoides
Protoparmelia badia
Pseudephebe pubescens
Pseudocalliergon angustifolium
Pseudocalliergon trifarium
Pseudoleskea atricha
Psilopilum cavifolium
Psoroma hypnorum
Ptychostomum archangelicum
Ptychostomum pallens
Ptychostomum pallescens
Racomitrium lanuginosum
Ranunculus eschscholtzii
Ranunculus nivalis
Ranunculus pygmaeus
Rhizocarpon atroflavescens
Rhizocarpon badioatrum
Rhizocarpon cf concentricum (yellow, aquatic)
Rhizocarpon chioneum
Rhizocarpon copelandii
Rhizocarpon lavatum
Rhizocarpon lecanorinum
Rhodiola integrifolia
Rhytidiopsis robusta
Rinodina turfacea
Rubus pedatus
Sagina saginoides
Salix arctica
Salix barrattiana
Salix cf. polaris
Salix nivalis
Salix reticulata
Sanguisorba stipulata
Sanionia uncinata
Sarmentypnum pseudosarmentosum
Saxifraga ascendens
Saxifraga hyperborea
Saxifraga mertensiana
Saxifraga tricuspidata
Scapania irrigua
Scapania obcordata
Scapania obscura?
Scapania paludosa
Scapania subalpina
Scapania uliginosa
Scapania undulata?
Schistochilopsis incisa var. opacifolia
Schofieldia monticola
Sedum divergens
Selaginella wallacei
Senecio triangularis
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Solorina crocea
Sorbus sitchensis
Sphaerophorus fragilis
Sphaerophorus globosus
Sphagnum aongstroemii
Sphagnum capillifolium
Sphagnum compactum
Sphagnum fimbriatum
Sphagnum girgensohnii
Sphagnum rubellum
Spilonema revertens
Stellaria calycantha
Stellaria monantha
Stereocaulon alpinum
Stereocaulon botryosum
Stereocaulon cumulatum
Stereocaulon klondikense
Stereocaulon nivale

Stereocaulon rivulorum
Stereocaulon symphycheilum
Stereocaulon tomentosum
Stereocaulon vesuvianum
Syntrichia princeps
Taraxacum alaskanum
Tephromela atra
Thamnolia vermicularis
Tortella tortuosa var. tortuosa
Trapeliopsis granulosa
Tremolecia atrata
Trientalis arctica
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Umbilicaria deusta
Umbilicaria havaasii
Umbilicaria hyperborea
Umbilicaria proboscidea
Umbilicaria torrefacta
Vaccinium membranaceum
Vaccinium ovalifolium
Vaccinium uliginosum
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Verrucaria margacea
Viola epipsila
Xanthoria sorediata

September 1, 2012, Vicinity of Brucejack Camp, on a West to Northwest Wandering Path

Abies lasiocarpa
Achillea millefolium var. alpinum
Aconitum delphiniifolium
Agoseris aurantiaca
Alectoria ochroleuca
Amygdalaria panaeola
Andreaea blyttii
Andreaea rupestris
Anemone parviflora
Anemone richardsonii
Aneura pinguis
Antennaria alpina
Antennaria monocephala ssp. monocephala
Antennaria rosea ssp. confinis
Anthelia juratzkana
Aquilegia formosa
Arabidopsis lyrata ssp. kamchatica
Arctoparmelia incurva
Arctous alpina
Arnica gracilis
Arnica latifolia
Artemisia norvegica
Arthrorhaphis alpina
Aspicilia (unknown species, brown hypothecium)
Asterella gracilis group
Athyrium americanum
Aulacomnium palustre
Barbilophozia lycopodioides
Bartramia ithyphylla
Bellemerea alpina
Bellemerea cinereorufa
Bellemerea subsorediza
Bistorta vivipara
Botrychium lunaria
Botrychium minganense
Brachythecium cirrhosum
Bryocaulon divergens
Bryoria fremontii
Bryoria nitidula
Bryoria tenuis
Bucklandiella heterosticha
Calamagrostis canadensis
Caloplaca exsecuta
Caloplaca holcoarpa
Caltha biflora
Campanula lasiocarpa
Campanula rotundifolia
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia

Cardamine umbellata
Carex albonigra
Carex atrata sensu stricto?
Carex atrosquama
Carex brunnescens
Carex cf enanderi
Carex lachenalii
Carex macrochaeta
Carex micropoda
Carex nardina
Carex nigricans
Carex saxatilis
Carex scirpoidea var. scirpoidea
Carex stylosa
Carex tahoensis
Cassiope mertensiana
Castilleja parviflora
Catapyrenium cinereum
Cerastium arvense (green form)
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria nigricans
Cetraria subalpina
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia bellidiflora
Cladonia borealis
Cladonia cariosa
Cladonia chlorophaea
Cladonia crispata ssp. cetrariiformis
Cladonia deformis
Cladonia ecmocyna intermedia
Cladonia gracilis elongata
Cladonia metacorallifera
Cladonia pyxidata
Cladonia rangiformis
Cladonia subfurcata
Cladonia sulphurina
Cladonia symphycarpia
Cladonia uncialis
Coelocaulon aculeatum
Collema ceraniscum
Conostomum tetragonum
Cornus unalaschkensis
Dactylina arctica
Dermatocarpon bachmanii
Dermatocarpon rivulorum
Dicranella palustris
Dicranum acutifolium?
Diphasiastrum alpinum
Diphasiastrum sitchense
Distichum capillaceum
Ditrichum flexicaule
Draba crassifolia
Draba nivalis
Draba sp nov
Draba stenoloba
Dryas integrifolia
Empetrum nigrum
Epilobium anagallidifolium
Epilobium angustifolium
Epilobium clavatum
Epilobium hornemannii ssp. hornemannii
Epilobium lactiflorum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron humilis
Erigeron nivalis
Euopsis granatina
Festuca altaica
Festuca brachyphylla?
Festuca groenlandica?
Festuca saximontana
Flavocetraria cucullata
Flavocetraria nivalis
Frutidella caesioatra
Gentiana glauca
Gentianella propinqua
Geranium erianthum
Gymnomitrion corallioides
Harrimanella stelleriana
Heuchera glabra
Hieracium triste (non-glandular)

Hierochloe alpina
Huperzia arctica
Huperzia haleakalae
Ionaspis odora
Juncus alpinoarticulatus
Juncus arcticus ssp. sitchensis
Juncus biglumis
Juncus drummondii
Juncus mertensianus
Jungermannia exsertifolia
Juniperus communis
Lecanora argopholis
Lecanora frustulosa
Lecanora marginalis
Lecanora polytropa
Lecanora rupicola
Lecidea auriculata
Lecidea beringeriana group (subsquamulose)
Lempholemma intricatum
Lepraria alpina
Leptarrhena pyrolifolia
Leptogium plicatile group
Lichinodium sirosiphoideum
Lloydia serotina var. serotina
Luetkea pectinata
Lupinus nootkatensis
Luzula arcuata
Luzula parviflora
Luzula spicata
Luzula wahlenbergii
Lycopodium annotinum ssp. pungens
Marsupella ustulata
Meesia uliginosa
Melanelia hepatizon
Melanelia stygia
Micranthes ferruginea
Micranthes lyallii
Micranthes nelsoniana var. porsildiana
Micranthes nivalis
Micranthes occidentalis
Micranthes tenuis
Minuartia rubella
Mitella pentandra
Mnium blyttii
Moerckia hibernica
Montia parvifolia
Myosotis asiatica
Nephroma arcticum
Nephroma expallidum
Niphotrichum canescens
Niphotrichum muticum
Nodobryoria subdivergens (sulcate)
Ochrolechia frigida
Onchophorus wahlenbergii
Ophioparma ventosa
Orphniospora moriformis
Oxyria digyna
Parmelia omphalodes
Parmeliopsis hyperopta
Parnassia fimbriata
Parnassia kotzebuei
Pedicularis sudetica
Peltigera chionophila
Peltigera malacea
Peltigera ponojensis
Peltigera praetextata
Peltigera scabrosa
Peltigera venosa
Petasites nivalis
Phaeophyscia sciastra
Philonotis fontana var. fontana
Phleum alpinum
Phyllodoce glanduliflora
Placopsis gelida
Placynthium nigrum
Plagiobryum demissum
Platismatia glauca
Pleurozium schreberi
Poa alpina
Poa arctica ssp. arctica
Poa paucispicula? (see specimen)
Poa pratensis ssp. colpodea
Pohlia cruda
Pohlia drummondii
Pohlia wahlenbergii
Polystichum lonchitis

Polytrichum juniperinum
Polytrichum piliferum
Polytrichum strictum
Porpidia contraponenda
Porpidia flavicunda
Porpidia thomsonii
Potentilla glaucophylla
Potentilla hyparctica ssp. elatior
Potentilla nana
Preissia quadrata
Pseudephebe pubescens
Pseudoleskea atricha
Pseudoleskea cf atricha
Psora globifera
Psoroma hypnorum
Ptilidium californicum
Racomitrium lanuginosum
Ramboldia cinnabarina
Ranunculus eschscholtzii
Ranunculus gelidus
Ranunculus nivalis
Ranunculus occidentalis ssp. hexastylis
Ranunculus pygmaeus
Rhizocarpon chioneum
Rhizocarpon geographicum
Rhizomnium nudum
Rhizomnium pseudopunctatum
Rhodiola integrifolia
Rhytidium rugosum
Rinodina mniaraea var. cinnamomea
Rinodina mniaraea var. mniaraea
Rinodina mniaraea var. mniaraeiza
Rubus pedatus
Sagina saginoides
Salix arctica
Salix barclayi
Salix cf. polaris
Salix nivalis
Salix reticulata
Sanguisorba stipulata
Sanionia uncinata
Sarmentypnum exannulatum
Sarmentypnum pseudosarmentosum
Saxifraga caespitosa
Saxifraga hyperborea
Saxifraga mertensiana
Saxifraga oppositifolia ssp. smalliana
Saxifraga tricuspidata
Scapania irrigua
Scapania paludosa
Schistidium cf. atrichum
Schistochilopsis incisa var. opacifolia
Schofieldia monticola
Selaginella wallacei
Senecio triangularis
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Solorina bispora
Solorina crocea
Solorina octospora
Sphaerophorus fragilis
Sphaerophorus globosus
Sphagnum rubellum
Sphagnum russowii
Staurothele areolata
Staurothele drummondii
Stellaria monantha
Stereocaulon alpinum
Stereocaulon botryosum
Stereocaulon intermedium
Stereocaulon klondikense
Stereocaulon nivale
Stereocaulon rivulorum
Stereocaulon tomentosum
Stereocaulon vesuvianum
Taraxacum alaskanum
Tayloria lingulata
Tephromela atra
Tetralophozia setiformis
Thamnolia vermicularis
Tofieldia pusilla
Trientalis arctica
Trisetum spicatum
Umbilicaria (unknown species, like U. cinereorufescens, but with lower surface pale

tan and rhizines in bundles)
Umbilicaria aprina?
Umbilicaria cf torrefacta
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria lambii
Umbilicaria proboscidea
Umbilicaria sp. (thalloconidiate, large, apotheciate, pruinose)
Umbilicaria torrefacta
Umbilicaria virginis
Vaccinium membranaceum
Vaccinium uliginosum
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Verrucaria margacea
Xanthoria candelaria
Xanthoria elegans
Xanthoria sorediata

September 2, 2012, Brucejack Camp to Base of Mountain Known in Camp as "Jabba the Hut"

Acarospora glaucocarpa
Antennaria howellii x alpina
Aspicilia (unknown species, bullate)
Aspicilia (unknown species, chalky)
Aspicilia (unknown species, grey aquatic)
Aspicilia (unknown species, rimmed aquatic)
Aspicilia aquatica
Aspicilia cf laevata
Bellemerea alpina
Bellemerea cinereorufa
Bellemerea sanguinea
Bryum calobryoides
Campylium stellatum
Cladonia cariosa
Cladonia pseudalcicornis
Cladonia pyxidata
Coelocaulon sp nov
Draba sp nov
Encalypta rhapdocarpa
Epilobium hornemannii ssp. behringianum
Epilobium latifolium
Euopsis granatina
Gymnomitrion obtusum
Gymnomitrion pacificum
Hypogymnia austerodes
Hypogymnia dichroma
Ionaspis lacustris
Lecidea alpestris (sensu Thomson)
Lecidoma demissum
Lepraria alpina
Lepraria membranacea
Leptogium saturninum
Massalongia carnosa
Mnium blyttii
Parnassia fimbriata
Phaeophyscia cf. nigricans (minute, ciliate, brown, fertile, non-isid/sored)
Phaeophyscia decolor
Phaeophyscia orbicularis
Philonotis fontana var. fontana
Poa alpina
Porella cordeana
Porpidia contraponenda
Porpidia sp nov (appearance like *Amygdalaria subdissentiens*)
Pseudoleskea cf atricha
Psilopilum cavifolium
Ranunculus eschscholtzii
Ranunculus nivalis
Ranunculus occidentalis ssp. hexastylis
Romanzoffia sitchensis
Salix alaxensis ssp. alaxensis
Salix barclayi
Salix cf ovalifolia
Salix nivalis
Salix sitchensis
Saxifraga hyperborea
Scapania obcordata
Schistidium cf. atrichum

Schistochilopsis incisa var. opacifolia
Schofieldia monticola
Selaginella wallacei
Sporastatia (unknown species, apothecia radially cracked)
Staurothele areolata
Staurothele fissa
Stellaria calycantha
Toninia ruginosa
Tortella tortuosa var. tortuosa
Umbilicaria lambii
Vestergrenopsis elaeina
Viola epipsila

September 3, 2012, Mouth of the Bowser River

Achillea millefolium var. alpinum
Agrostis scabra
Alnus viridis ssp. sinuata
Calamagrostis canadensis
Carex flava
Carex hoodii
Carex lenticularis limnophila
Castilleja miniata
Cladonia cenotea
Cladonia ecmocyna occidentalis
Cladonia macilenta
Cornus stolonifera
Dryas drummondii
Elymus glaucus
Epilobium angustifolium
Epilobium ciliatum ssp. ciliatum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron acris kamtchaticus
Festuca saximontana
Fragaria vesca
Galium triflorum
Geum macrophyllum
Hieracium albiflorum
Juncus alpinoarticulatus
Juncus arcticus ssp. sitchensis
Juncus castaneus
Juncus ensifolius
Juncus mertensianus
Lupinus nootkatensis
Luzula parviflora
Montia parvifolia
Niphotrichum canescens
Osmorhiza berteroi
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia fimbriata
Peltigera ponojensis
Philonotis fontana var. fontana
Phleum alpinum
Platanthera dilitata var. dilitata
Poa alpina
Polytrichum juniperinum
Polytrichum piliferum
Populus balsamifera
Prunella vulgaris
Ptychostomum pallescens
Salix alaxensis ssp. alaxensis
Salix barclayi
Salix discolor
Salix drummondiana
Streptopus amplexifolius
Symphyotrichum lanceolatum

September 3, 2012, Proposed Leaching Pond Southeast of Wildfire Camp

Abies lasiocarpa
Agrostis mertensii
Alnus viridis ssp. sinuata
Aulacomnium androgynum
Aulacomnium palustre
Barbilophozia floerkii
Barbilophozia lycopodioides
Calamagrostis canadensis
Carex aquatilis var. aquatilis
Carex magellanica ssp. irrigua
Carex sitchensis
Carex tahoensis
Chimaphila umbellata
Cladonia coniocrea
Cladonia gracilis turbinata
Dicranoweisia crispula
Dicranum pallidisetum
Dicranum tauricum
Epilobium ciliatum ssp. glandulosum
Epilobium palustre
Equisetum arvense
Equisetum fluviatile
Erigeron peregrinus
Gymnocarpium dryopteris
Hylocomium splendens
Hypnum circinale
Isothecium stoloniferum
Juncus filiformis
Lepraria incana
Lescurea baileyi
Luetkea pectinata
Luzula parviflora
Mitella pentandra
Mycoblastus sanguinarius
Nuphar variegatum
Oplopanax horridus
Orthilia secunda
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia fimbriata
Pellia neesiana
Peltigera chionophila
Plagiomnium medium
Platanthera dilitata var. dilitata
Platismatia glauca
Potamogeton epihydrus? (couldn't collect, out of reach in an open water pool)
Pseudocalliergon trifarium
Ptilidium californicum
Ptilium crista-castrensis
Pyrola asarifolia
Pyrola minor
Ramboldia cinnabarina
Rhizomnium pseudopunctatum
Rhytidiopsis robusta
Ribes lacustre
Roellia roellii
Rubus pedatus
Salix drummondiana
Salix pseudomonticola
Sanionia uncinata
Sarmentypnum exannulatum
Schistochilopsis incisa var. incisa
Sciurohypnum hylotapetum
Sparganium natans? (immature)
Sphagnum fallax
Sphagnum pacificum
Sphagnum riparium
Sphagnum russowii
Sphagnum squarrosum
Sphagnum subsecundum
Sphagnum teres
Streptopus lanceolatus
Tiarella unifoliata
Trientalis arctica
Tsuga mertensiana
Vaccinium membranaceum
Vaccinium ovalifolium
Viola orbiculata

September 3, 2012, Wetland with Dwarfed Conifers East above Scott Creek

Abies lasiocarpa
Agrostis exarata
Alectoria sarmentosa
Alnus viridis ssp. sinuata
Aneura pinguis
Arnica latifolia
Athyrium filix-femina
Aulacomnium palustre
Barbilophozia floerkii
Barbilophozia hatcheri
Calamagrostis canadensis
Carex cf heleonastes
Carex magellanica ssp. irrigua
Carex sitchensis
Cetraria subalpina
Chimaphila umbellata
Cladonia carneola
Cladonia cenotea
Cladonia crispata ssp. crispata
Cladonia deformis
Cladonia sulphurina
Clintonia uniflora
Comarum palustre
Cornus canadensis
Dicranum pallidisetum
Dicranum scoparium
Dicranum tauricum
Epilobium angustifolium
Epilobium ciliatum ssp. ciliatum
Epilobium leptocarpum
Equisetum arvense
Galium trifidum
Gymnocarpium dryopteris
Huperzia chinensis
Hylocomium splendens
Hypnum circinale
Lophozia turbinata
Mitella pentandra
Mycoblastus sanguinarius
Orthilia secunda
Parmeliopsis ambigua
Parmeliopsis hyperopta
Pellia neesiana
Platanthera dilitata var. dilitata
Pleurozium schreberi
Polytrichum strictum
Ptilidium californicum
Ramboldia cinnabarina
Rhizomnium nudum
Rhizomnium pseudopunctatum
Rhytidiopsis robusta
Roellia roellii
Rubus arcticus
Rubus parviflorus
Salix pseudomonticola
Sanionia uncinata
Schistochilopsis incisa var. incisa
Sciurohypnum hylotapetum
Senecio triangularis
Sphagnum angustifolium
Sphagnum annulatum
Sphagnum pacificum
Sphagnum riparium
Sphagnum russowii
Sphagnum squarrosum
Sphagnum subnitens
Sphagnum subsecundum
Sphagnum teres
Stellaria borealis
Straminergon stramineum
Streptopus lanceolatus
Symphyotrichum foliaceum
Tiarella unifoliata
Trientalis arctica
Tsuga mertensiana
Vaccinium membranaceum
Vaccinium ovalifolium
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Viola epipsila
Vulpicida pinastri
Warnstorfia fluitans
Xylographa parallela
Xylographa soralifera

July 10, 2013, Southwest of Knipple Lake

Abies lasiocarpa
Acarospora glaucocarpa
Acarospora sinopica
Acer glabrum
Achillea millefolium var. *borealis*
Adiantum aleuticum
Agoseris aurantiaca ssp. *aurantiaca*
Alnus viridis ssp. sinuata
Amygdalaria consentiens
Anaphalis margaritacea
Andreaea rupestris
Antennaria rosea
Antennaria umbrinella
Arabidopsis lyrata ssp. *kamchatica*
Arnica latifolia
Asplenium viride
Athyrium americanum
Athyrium filix-femina
Baeomyces rufus
Barbilophozia hatcheri
Bartramia ithyphylla
Bellemerea cinereorufescens
Bellemerea subsorediza
Blepharostoma trichophyllum
Bucklandiella sudetica
Calamagrostis canadensis
Campylophyllum halleri
Candelariella vitellina
Cardamine umbellata
Carex lenticularis var. *lipocarpa*
Carex phaeocephala
Carex tahoensis
Cassiope mertensiana
Catapyrenium daedaleum
Cinna latifolia
Cladina arbuscula
Cladonia borealis
Cladonia cariosa
Cladonia carneola
Cladonia cenotea
Cladonia cervicornis
Cladonia chlorophaea
Cladonia coccifera
Cladonia cornuta ssp. *cornuta*
Cladonia ecmocyna intermedia
Cladonia macrophyllodes
Cladonia pyxidata
Cladonia squamosa
Cladonia stricta
Cladonia sulphurina
Cladonia symphycarpia
Cryptogramma acrostichoides
Cryptogramma sitchensis?
Cystopteris fragilis (erect and stiff, non-glandular form)
Danthonia spicata
Dichodontium pellucidum
Distichum capillacium
Ditrichum flexicaule
Draba aurea
Draba stenoloba
Dryas drummondii
Dryopteris expansa
Dryptodon patens
Encalypta procera
Epilichen scabrosus
Epilobium anagallidifolium
Epilobium angustifolium
Epilobium clavatum
Epilobium lactiflorum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron nivalis
Festuca saximontana ssp. *purpusiana*
Grimmia sessitana
Gymnocarpium disjunctum
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Gymnomitrion obtusifolium
Gymnomitrion pacificum
Heuchera glabra
Hieracium albiflorum

Huperzia chinensis
Ionaspis lacustris
Juncus drummondii
Lecanora stenotropa
Lecidea hypnorum
Lepraria alpina
Leptarrhena pyrolifolia
Luetkea pectinata
Marchantia polymorpha
Massalongia carnosa
Menziesia ferruginea
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Minuartia rubella
Mitella pentandra
Mycobilimbia epixanthoides
Nephroma parile
Niphotrichum canescens
Niphotrichum elongatum
Orthilia secunda
Osmorhiza purpurea
Oxyria digyna
Pellia neesiana
Peltigera malacea
Peltigera membranacea
Peltigera ponojensis
Peltigera praetextata
Phaeophyscia decolor
Phegopteris connectilis
Phyllodoce glanduliflora
Physconia muscigena
Placopsis gelida
Poa alpina
Poa glauca ssp. *rupicola*
Poa interior
Poa leptocoma
Poa nemoralis
Polyblastia cucurbitula
Polypodium vulgare s. str.?
Polysporina simplex
Polystichum andersonii
Polystichum lonchitis
Polytrichum juniperinum
Populus trichocarpa
Protopannaria pezizoides
Protothelenella sphinctrinoides
Psoroma hypnorum
Ptilidium ciliare
Ptilium crista-castrense
Ptychostomum pallescens
Ranunculus nivalis
Ranunculus pygmaeus
Rhizocarpon geographicum
Ribes laxiflorum
Sagina saginoides
Salix commutata
Salix drummondiana
Salix glauca
Salix petrophila
Salix planifolia
Salix prolixa
Salix pseudomonticola
Salix scouleriana
Salix sitchensis
Sanguisorba stipularis
Sanionia uncinata
Saxifraga mertensiana
Saxifraga tricuspidata
Schistidium frigidum
Senecio triangularis
Shepherdia canadensis
Stellaria sitchensis
Stereocaulon alpinum
Stereocaulon intermedium
Stereocaulon paschale
Stereocaulon spathuliferum
Tortella tortuosa
Trapeliopsis granulosa
Trisetum spicatum
Tritomaria exsectiformis
Tsuga mertensiana
Umbilicaria cylindrica
Umbilicaria hyperborea
Vaccinium membranaceum
Vaccinium ovalifolium
Vestergrenopsis elaeina

Vestergrenopsis isidiata
Woodsia scopulina

July 10, 2013, Opposite Side of Lake Outlet from Site 1, Extensive Cobble Benches and Moraine

Abies lasiocarpa
Alnus viridis ssp. *sinuata*
Anastrophyllum minutum
Arabis eschscholtzii
Boechera stricta
Brachythecium spp. (coll)
Bucklandiella sudetica
Castilleja miniata x *unalaschcensis*
Ceratodon purpureus
Cladina arbuscula
Cladonia bellidiflora
Cladonia borealis
Cladonia chlorophaea
Cladonia ecmocyna intermedia
Cladonia ecmocyna occidentalis
Cladonia fimbriata
Cladonia macrophyllodes
Cladonia sulphurina
Cryptogramma acrostichoides
Dryas drummondii
Epilobium angustifolium
Epilobium clavatum
Epilobium lactiflorum
Festuca occidentalis
Heracleum lanatum
Hieracium albiflorum
Hylocomium splendens
Juniperus communis
Melica subulata
Niphotrichum canescens
Orthilia secunda
Peltigera britannica
Peltigera conspersa
Peltigera malacea
Peltigera praetextata
Phaeophyscia decolor
Piperia unalaschcensis
Plagiomnium medium
Poa alpina
Polypodium vulgare s. str.?
Polystichum lonchitis
Polytrichum juniperinum
Populus trichocarpa
Pseudoleskea baileyi
Ribes laxiflorum
Salix alaxensis ssp. *longistylis*
Salix drummondiana
Salix petrophila
Salix pseudomonticola
Salix sitchensis
Saxifraga tricuspidata
Sciurohypnum oedopodium
Sedum divergens
Shepherdia canadensis
Solorina crocea
Sorbus sitchensis
Stereocaulon paschale
Tiarella unifoliata
Trapeliopsis granulosa
Tritomaria quinquedentata
Tsuga mertensiana
Vaccinium ovalifolium

July 11, 2013, Glacial Outwash Area, then Upslope on the Rock

Abies lasiocarpa
Alnus viridis ssp. *sinuata*
Aneura pinguis
Aongstroemia longipes
Athyrium americanum
Aulacomnium palustre
Blasia pusilla
Bucklandiella sudetica
Carex lenticularis var. *lipocarpa*
Juncus arcticus ssp. *sitchensis*

Palustriella falcata
Platanthera aquilonis
Pohlia sp. nov.
Ptychostomum schleicheri
Stereocaulon glareosum
Tsuga mertensiana

July 11, 2013, Starting at 9V 433828 6230767, near the Salmon Glacier

Abies lasiocarpa
Alectoria sarmentosa
Amygdalaria panaeola
Anaphalis margaritacea
Anastrophyllum sphenoloboides
Andreaea blyttii
Andreaea nivalis
Andreaea rupestris
Anthelia julacea
Anthelia juratzkana
Aquilegia formosa
Arabidopsis lyrata ssp. *kamchatica*
Arnica latifolia
Artemisia norvegica
Aruncus dioica
Asterella gracilis
Athyrium americanum
Baeomyces rufus
Bartramia ithyphylla
Biatora cuprea
Biatora toensbergii
Blepharostoma trichophyllum
Botrychium lunaria
Botrychium spathulatum
Bucklandiella sudetica
Caltha biflora
Calypogeia integristipula
Campanula lasiocarpa
Cardamine umbellata
Carex macloviana
Carex macrochaeta
Carex mertensii
Carex micropoda
Carex nigricans
Carex phaeocephala
Cassiope mertensiana
Castilleja miniata x *unalaschcensis*
Castilleja parviflora
Catapyrenium cinereum
Catapyrenium daedaleum
Cetraria islandica ssp. *crispiformis*
Cetraria subalpina
Chiloscyphus pallescens
Cladina mitis
Cladina portentosa
Cladina rangiferina
Cladonia bellidiflora
Cladonia borealis
Cladonia gracilis ssp. *elongata*
Cladonia kanewskii
Cladonia macrophyllodes
Cladonia singularis
Cladonia squamosa
Cladonia stricta
Cladonia uncialis
Cladonia wainioi
Claopodium bolanderi
Conostomum tetragonum
Cryptogramma acrostichoides
Cryptogramma sitchensis?
Cynodontium tenellum
Cystopteris fragilis (erect, stiff, non-glandular form)
Cystopteris fragilis (normal form)
Dermatocarpon rivulorum
Dicranella palustris
Dicranoweisia crispula
Dicranum montanum
Dicranum scoparium
Diphasiastrum sitchense
Diplophyllum taxifolium
Dryas drummondii
Dryopteris expansa
Dryopteris filix-mas
Epilobium anagallidifolium
Epilobium clavatum
Epilobium latifolium
Euopsis pulvinata
Frutidella caesioatra

Geranium erianthum
Grimmia alpestris
Grimmia sessitana
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Gymnocolea inflata
Gymnomitrion concinnatum
Gymnomitrion obtusifolium
Harimanella stelleriana
Harpanthus flotowianus
Heracleum lanatum
Heuchera glabra
Hieracium triste
Hippuris montana
Huperzia chinensis
Hygrohypnum luridum
Icmadophila ericetorum
Juncus drummondii
Kalmia microphylla
Kiaeria blytii
Kiaeria falcata
Lecanora cadubriae
Lecidea beringeriana
Lecidea betulicola
Lecidea lapicida
Lecidoma demissum
Leptarrhena pyrolifolia
Listera cordata
Lobaria linita
Loiseleuria procumbens
Luetkea pectinata
Lupinus nootkatensis
Luzula parviflora
Luzula piperi
Marsupella brevissima
Marsupella emarginata
Massalongia carnosa
Menziesia ferruginea
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Micranthes tolmiei
Mitella breweri
Moerckia blyttii
Mylia taylorii
Myochroidea leprosula
Myochroidea rufofusca
Nephroma arcticum
Niphotrichum canescens
Oligotrichum paralellum
Onchophorus virens
Orthilia secunda
Osmorhiza purpurea
Oxyria digyna
Palustriella falcata
Parnassia fimbriata
Pellia neesiana
Peltigera chionophila
Peltigera membranacea
Peltigera neopolydactyla
Peltigera scabrosa
Peltigera venosa
Pertusaria geminipara
Petasites nivalis
Phaeophyscia decolor
Philonotis fontana var. *fontana*
Phleum alpinum
Phyllodoce glanduliflora
Pilophorus dovrensis
Pilophorus nigricaulis
Placopsis gelida
Plagiothecium laetum
Pleurocladula albescens
Poa paucispicula
Pohlia cruda
Polyblastia cucurbitula
Polysporina simplex
Polystichum lonchitis
Preissia quadrata
Protopannaria pezizoides
Psoroma hypnorum
Pyrenopsis haemaleella
Radula complanata
Ramboldia cinnabarina
Ranunculus cooleyae
Ranunculus eschscholtzii
Ranunculus nivalis
Ranunculus pygmaeus
Rhizomnium magnifolium
Rhytidium rugosum
Ribes laxiflorum
Rubus pedatus
Rubus spectabilis

Sagina saginoides
Salix petrophila
Salix sitchensis
Sanguisorba stipularis
Sarmentypnum exannulatum
Saxifraga mertensiana
Saxifraga tricuspidata
Scapania obcordata
Schistochilopsis opacifolia
Schofieldia monticola
Sciurohypnum latifolium
Senecio triangularis
Sibbaldia procumbens
Solorina crocea
Solorina spongiosa
Sorbus sitchensis
Sphagnum contortum
Sphagnum teres
Stellaria sitchensis
Stereocaulon klondikense
Stereocaulon paschale
Stereocaulon rivulorum
Stereocaulon spathuliferum
Straminergon stramineum
Tellima grandiflora
Tortella tortuosa
Trapeliopsis granulosa
Trisetum spicatum
Tsuga mertensiana
Umbilicaria hyperborea
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium ovalifolium
Vaccinium uliginosum
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Vestergrenopsis elaeina
Vestergrenopsis isidiata
Viola glabella
Viola langsdorfii
Woodsia scopulina

July 11, 2013, Starting at 9V 436782 6250386, Rock Outcrops above Tipacanoe Lake

Abies lasiocarpa
Agrostis scabra
Alnus viridis ssp. *sinuata*
Anaphalis margaritacea
Arabis eschscholtzii
Arnica prima
Aruncus dioica
Bellemerea cinereorufescens
Boechera divaricarpa
Bryoria fuscescens
Bucklandiella sudetica
Calamagrostis canadensis
Candelariella vitellina
Carex aurea
Carex lenticularis var. *lipocarpa*
Carex mertensii
Carex phaeocephala
Carex scirpoidea
Cassiope mertensiana
Castilleja miniata x *unalaschcensis*
Cladonia bellidiflora
Cladonia borealis
Cladonia ecmocyna ssp. *intermedia*
Cladonia macrophyllodes
Cladonia pleurota
Cladonia pyxidata
Cladonia stricta
Cryptogramma acrostichoides
Diplophyllum taxifolium
Ditrichum gracile
Dryas drummondii
Dryopteris expansa
Elymus glaucus
Epilobium angustifolium
Epilobium clavatum
Epilobium latifolium
Equisetum variegatum
Festuca saximontana ssp. *purpusiana*
Gymnomitrion obtusifolium
Hieracium albiflorum
Huperzia chinensis
Hypogymnia occidentalis

Lecanora chlarotera
Lecanora fuscescens
Lecanora polytropa
Lepraria alpina
Lupinus nootkatensis
Luzula parviflora
Melanohalea septentrionalis
Mycobilimbia tetramera
Niphotrichum canescens
Ochrolechia szatalaensis
Oplopanax horridus
Orthilia secunda
Parmeliopsis ambigua
Parmeliopsis hyperopta
Peltigera membranacea
Phleum alpinum
Phyllodoce glanduliflora
Pinguicula vulgaris
Placopsis gelida
Platanthera dilitata
Poa glauca ssp. *rupicola*
Polystichum lonchitis
Populus trichocarpa
Pyrola asarifolia
Ribes laxiflorum
Rinodina mniaeraea
Sagina saginoides
Salix arctica
Salix commutata
Salix drummondiana
Salix glauca
Salix petrophila
Salix scouleriana
Sanguisorba stipularis
Saxifraga tricuspidata
Shepherdia canadensis
Solidago multiradiata
Sorbus sitchensis
Stereocaulon paschale
Stereocaulon tomentosum
Stuckenia sp. (same as at KSM)
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Tuckermannopsis chlorophylla
Umbilicaria torrefacta
Vaccinium membranaceum
Vaccinium ovalifolium
Valeriana sitchensis
Vestergrenopsis isidiata

July 13, 2013, Site 1 near Salmon Glacier, Starting from near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*
Alectoria sarmentosa
Anaphalis margaritacea
Anthelia juratzkana
Arabidopsis lyrata ssp. *kamchatica*
Arnica latifolia
Artemisia norvegica
Asterella gracilis
Athyrium americanum
Barbilophozia lycopodioides
Bartramia ithyphylla
Biatora flavopunctata
Bistorta vivipara
Bryoria trichodes ssp. *americana*
Bucklandiella sudetica
Carex macrochaeta
Carex nigricans
Cassiope mertensiana
Catapyrenium daedaleum
Cetraria subalpina
Cinclidium stygium
Cirsium edule
Cladonia bellidiflora
Cladonia borealis
Cladonia carneola
Cladonia chlorophaea
Cladonia ecmocyna ssp. *intermedia*
Cladonia gracilis ssp. *elongata*
Cladonia macrophyllodes
Cladonia stricta
Cladonia subfurcata
Cladonia sulphurina
Diphasiastrum sitchense
Dryopteris expansa
Empetrum nigrum

Epilichen scabrosus
Epilobium anagallidifolium
Epilobium angustifolium
Epilobium clavatum
Epilobium latifolium
Equisetum variegatum
Erigeron nivalis
Erythranthe lewisii
Fissidens osmundoides
Fuscopannaria praetermissa group
Geum macrophyllum var. *macrophyllum*
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Harimanella stelleriana
Harpanthus flotowianus
Hygrohypnum cf. *eurgyrium*
Hypogymnia inactiva
Hypogymnia rugosa
Ionaspis lacustris
Juncus drummondii
Juncus mertensiana
Kiaeria blytii
Leptarrhena pyrolifolia
Loiseleuria procumbens
Luetkea pectinata
Lupinus nootkatensis
Luzula parviflora
Marsupella emarginata
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Micranthes tolmiei
Mitella breweri
Mitella pentandra
Mnium lycopodioides
Mycobilimbia epixanthoides
Myochroidea rufofusca
Nephroma arcticum
Nephroma parile
Niphotrichum canescens
Niphotrichum muticum
Osmorhiza purpurea
Oxyria digyna
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia fimbriata
Peltigera chionophila
Peltigera malacea
Peltigera scabrosa
Petasites nivalis
Philonotis fontana var. *fontana*
Phleum alpinum
Poa alpina
Poa paucispicula
Pohlia nutans
Polystichum lonchitis
Porella cordeana
Preissia quadrata
Protopannaria pezizoides
Protothelenella sphinctrinoides
Pseudoleskea atricha
Pseudoleskea baileyi
Psoroma hypnorum
Ptilidium pulcherrimum
Ptychostomum pseudotriquetrum
Pycnora leucococca
Ramboldia cinnabarina
Ramboldia subcinnabarina
Rhizomnium magnifolium
Rubus pedatus
Salix petrophila
Salix sitchensis
Sanguisorba stipularis
Sarmentypnum exannulatum
Scapania americana
Schistochilopsis opacifolia
Sibbaldia procumbens
Solorina crocea
Sphagnum compactum
Steineropsis alaskana
Stellaria sitchensis
Stereocaulon grande
Stereocaulon paschale
Tayloria lingulata
Thamnobryum neckeroides
Tortella tortuosa
Tsuga mertensiana
Vaccinium membranaceum
Vaccinium ovalifolium
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Vestergrenopsis elaeina

July 13, 2013, Site 2 Near Salmon Glacier, Starting from near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Amygdalaria panaeola
Andreaea rupestris
Arnica griscomii ssp. *frigida*
Athyrium americanum
Bartramia ithyphylla
Bryoria trichodes ssp. americana
Bucklandiella sudetica
Carex lachenalii
Carex nigricans
Cassiope mertensiana
Cetraria subalpina
Cladina rangiferina
Cladonia bellidiflora
Cladonia carneola
Cladonia chlorophaea
Cladonia cornuta ssp. *groenlandica*
Cladonia ecmocyna ssp. *intermedia*
Cladonia ecmocyna ssp. *occidentalis*
Cladonia squamosa
Cladonia sulphurina
Dicranum scoparium
Diphasiastrum sitchense
Diplophyllum taxifolium
Epilobium angustifolium
Epilobium latifolium
Equisetum arvense
Euopsis pulvinata
Frutidella pullata
Gymnocarpium x *intermedium*
Gymnomitrion corallioides
Heuchera glabra
Hippuris montana
Hypogymnia inactiva
Hypogymnia rugosa
Juncus drummondii
Kiaeria blytii
Leptarrhena pyrolifolia
Lobaria linita
Luetkea pectinata
Luzula parviflora
Lycopodium lagopus
Marsupella brevissima
Marsupella emarginata
Menziesia ferruginea
Mitella pentandra
Moerckia blyttii
Nephroma arcticum
Nephroma parile
Niphotrichum canescens
Onchophorus virens
Orthilia secunda
Parmeliopsis hyperopta
Parnassia fimbriata
Peltigera extenuata
Peltigera membranacea
Peltigera scabrosa
Philonotis fontana var. *fontana*
Phyllodoce glanduliflora
Porpidia flavicunda
Protopannaria pezizoides
Psoroma hypnorum
Ptilidium pulcherrimum
Rhizocarpon lavatum
Rhizocarpon lecanorinum
Salix pseudomonticola
Salix sitchensis
Schistochilopsis opacifolia
Senecio triangularis
Solorina crocea
Stereocaulon grande
Stereocaulon paschale
Trapeliopsis granulosa
Tsuga mertensiana
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium ovalifolium
Vahlodea atropurpurea
Veratrum viride
Woodsia scopulina

July 13, 2013, Site 3 near Salmon Glacier, Starting from Near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Amygdalaria panaeola
Bartramia ithyphylla
Biatora toensbergii
Caloplaca sorocarpa
Carex brunnescens
Carex nigricans
Cassiope mertensiana
Cladina rangiferina
Cladonia bellidiflora
Cladonia borealis
Cladonia singularis
Cystopteris fragilis (normal form)
Diphasiastrum sitchense
Eriophorum angustifolium
Fauria crista-galli
Gymnomitrion obtusifolium
Haematomma ochroleucum
Harimanella stelleriana
Heuchera glabra
Kalmia microphylla
Lobaria linita
Loeskypnum badium
Luetkea pectinata
Myochroidea leprosula
Niphotrichum canescens
Phyllodoce glanduliflora
Pilophorus dovrensis
Pohlia cruda
Pohlia proligera
Polystichum lonchitis
Polytrichum juniperinum
Psoroma hypnorum
Ramboldia cinnabarina
Rubus pedatus
Sorbus sitchensis
Sphagnum teres
Stereocaulon alpinum
Stereocaulon klondikense
Stereocaulon nivale
Stereocaulon paschale
Trapeliopsis granulosa
Tsuga mertensiana
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium ovalifolium
Valeriana sitchensis
Veratrum viride

July 13, 2013, Site 4 near Salmon Glacier, Starting from near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*
Anaphalis margaritacea
Arnica latifolia
Athyrium americanum
Baeomyces rufus
Bistorta vivipara
Brachytheciastrum leibergii
Caltha biflora
Cardamine umbellata
Carex macrochaeta
Carex mertensii
Castilleja parviflora
Cladonia chlorophaea
Cladonia ecmocyna ssp. *occidentalis*
Cladonia gracilis ssp. *elongata*
Cladonia squamosa
Cladonia sulphurina
Ditrichum gracile
Encalypta procera
Epilobium anagallidifolium
Epilobium hornemannii ssp. *beringianum*
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Gymnocarpium jessoense
Gymnocarpium x intermedium
Juncus mertensiana
Leptarrhena pyrolifolia
Luetkea pectinata
Luzula parviflora
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Mitella breweri

Niphotrichum canescens
Parnassia fimbriata
Peltigera malacea
Peltigera membranacea
Peltigera venosa
Petasites nivalis
Philonotis fontana var. *fontana*
Phyllodoce glanduliflora
Platanthera dilitata
Pogonatum contortum
Polystichum lonchitis
Pseudoleskea atricha
Salix cf. *polaris*
Salix commutata
Salix petrophila
Salix sitchensis
Sambucus racemosus
Sanguisorba stipularis
Sarmentypnum pseudosarmentosum
Saxifraga hyperborea
Saxifraga mertensiana
Scapania irrigua
Schistochilopsis opacifolia
Sorbus sitchensis
Stereocaulon paschale
Tsuga mertensiana
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium ovalifolium
Vahlodea atropurpurea

July 13, 2013, Site 5 near Salmon Glacier, Starting from near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Amphidium lapponicum
Anaphalis margaritacea
Anastrophyllum michauxii
Andreaea rupestris
Anthelia julacea
Arctoa fulvella
Athyrium americanum
Bartramia ithyphylla
Blindia acuta
Calamagrostis canadensis
Campanula lasiocarpa
Cardamine umbellata
Carex phaeocephala
Cassiope mertensiana
Cladina rangiferina
Cladonia carneola
Dicranella palustris
Dicranoweisia crispula
Diplophyllum taxifolium
Epilobium latifolium
Erythranthe lewisii
Fauria crista-galli
Gymnomitrion obtusifolium
Heuchera glabra
Hieracium triste
Hylocomium splendens
Juncus drummondii
Kiaeria falcata
Leptarrhena pyrolifolia
Lobaria linita
Loiseleuria procumbens
Luetkea pectinata
Menziesia ferruginea
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Niphotrichum canescens
Oligotrichum paralellum
Oxyria digyna
Parnassia fimbriata
Peltigera leucophlebia
Peltigera membranacea
Peltigera venosa
Placopsis gelida
Poa paucispicula
Pohlia cruda
Polyblastia cucurbitula
Porpidia flavicunda
Preissia quadrata
Ranunculus nivalis
Ranunculus pygmaeus
Rhizomnium magnifolium
Sagina saginoides
Salix petrophila
Salix sitchensis
Saxifraga mertensiana

Solorina crocea
Solorina saccata
Stellaria sitchensis
Stereocaulon paschale
Tsuga mertensiana
Vaccinium membranaceum
Vaccinium ovalifolium
Vahlodea atropurpurea
Valeriana sitchensis

July 13, 2013, Site 6 near Salmon Glacier, Starting from near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Anaphalis margaritacea
Anemone parviflora
Arabidopsis lyrata ssp. *kamchatica*
Athyrium americanum
Carex macrochaeta
Carex phaeocephala
Cassiope mertensiana
Cryptogramma acrostichoides
Dryopteris filix-mas
Epilobium clavatum
Epilobium hornemannii ssp. *beringianum*
Epilobium lactiflorum
Epilobium latifolium
Galium triflorum
Gymnocarpium jessoense
Ionaspis lacustris
Leptarrhena pyrolifolia
Luzula parviflora
Menziesia ferruginea
Micranthes lyallii
Micranthes tolmiei
Niphotrichum canescens
Oxyria digyna
Petasites nivalis
Phyllodoce glanduliflora
Polystichum lonchitis
Salix sitchensis
Saxifraga mertensiana
Solorina crocea
Solorina saccata
Tortella tortuosa
Trisetum spicatum

July 13, 2013, Site 7 near Salmon Glacier, Starting from near the Tunnel to the Bear Man Kiosk

Abies lasiocarpa
Amygdalaria consentiens
Andreaea blyttii
Andreaea rupestris
Andreaea sinuosa
Anthelia juratzkana
Athyrium americanum
Calamagrostis canadensis
Carex enanderi
Carex nigricans
Cassiope mertensiana
Castilleja parviflora
Cetraria subalpina
Cladina mitis
Cladina portentosa
Cladonia bellidiflora
Cladonia chlorophaea
Cladonia ecmocyna intermedia
Cladonia pseudalcicornis
Cladonia singularis
Cryptogramma acrostichoides
Cryptogramma sitchensis?
Dermatocarpon rivulorum
Diphasiastrum sitchense
Epilobium anagallidifolium
Epilobium clavatum
Epilobium latifolium
Erigeron nivalis
Euopsis pulvinata
Fauria crista-galli
Frutidella caesioatra
Gymnocarpium jessoense
Gymnomitrion obtusifolium
Hippuris montana

Huperzia arctica
Huperzia chinensis
Juncus drummondii
Juncus mertensiana
Jungermannia eucordifolia
Kiaeria blytii
Koerberiella wimmeriana
Leptarrhena pyrolifolia
Luetkea pectinata
Marchantia alpina
Menziesia ferruginea
Micranthes tolmiei
Nephroma arcticum
Niphotrichum canescens
Onchophorus virens
Palustriella falcata
Parnassia fimbriata
Peltigera aphthosa
Peltigera chionophila
Petasites nivalis
Phyllodoce glanduliflora
Pilophorus nigricaulis
Poa paucispicula
Polystichum lonchitis
Pyrenopsis haemaleella
Ranunculus nivalis
Ranunculus pygmaeus
Rhizocarpon lavatum
Rhytidiadelphus subpinnatus
Salix petrophila
Salix sitchensis
Sarmentypnum exannulatum
Saxifraga tricuspidata
Schistochilopsis opacifolia
Sibbaldia procumbens
Solorina crocea
Stereocaulon alpinum
Stereocaulon grande
Stereocaulon intermedium
Stereocaulon klondikense
Stereocaulon nivale
Stereocaulon paschale
Stereocaulon spathuliferum
Thamnolia vermicularis
Tsuga mertensiana
Umbilicaria hyperborea
Vaccinium caespitosum
Vahlodea atropurpurea

July 14, 2013, Site 1, Starting at 9V 434741 6225405 from the Main Salmon Glacier Overlook to Upslope and South

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*
Amphidium lapponicum
Amygdalaria panaeola
Anaphalis margaritacea
Andreaea blyttii
Andreaea rupestris
Anemone parviflora
Aneura pinguis
Antennaria alpina
Antennaria umbrinella
Anthelia julacea
Arnica latifolia
Arnica mollis
Artemisia norvegica
Asterella gracilis
Athyrium americanum
Barbilophozia lycopodioides
Bartramia ithyphylla
Bryoria trichodes ssp. *americana*
Caltha biflora
Campanula lasiocarpa
Carex anthoxanthea
Carex brunnescens
Carex enanderi
Carex lachenalii
Carex macrochaeta
Carex nardina
Carex nigricans
Carex scirpoidea
Cassiope mertensiana
Castilleja parviflora
Catapyrenium daedaleum
Cetraria subalpina
Cinclidium stygium
Cirsium edule

Cladina mitis
Cladina portentosa
Cladonia bellidiflora
Cladonia carneola
Cladonia chlorophaea
Cladonia ecmocyna ssp. *intermedia*
Cladonia gracilis ssp. *elongata*
Cladonia kanewskii
Cladonia macrophyllodes
Cladonia pleurota
Cladonia pseudalcicornis
Cladonia singularis
Cladonia sulphurina
Coelocaulon muricatum
Conostomum tetragonum
Cryptogramma acrostichoides
Cryptogramma sitchensis?
Cryptothele sp.
Cynodontium schistii
Cystopteris fragilis (erect and stiff, non-glandular form)
Cystopteris fragilis (normal form)
Dermatocarpon rivulorum
Dicranum scoparium
Diphasiastrum sitchense
Diplophyllum taxifolium
Distichum capillacium
Ditrichum flexicaule
Dryopteris expansa
Epilobium anagallidifolium
Epilobium clavatum
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron peregrinus var. *peregrinus*
Eriophorum angustifolium
Euopsis pulvinata
Fissidens osmundoides
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Gymnomitrion obtusifolium
Harimanella stelleriana
Heuchera glabra
Hieracium triste
Hippuris montana
Huperzia arctica
Huperzia chinensis
Huperzia haleakalae
Hypogymnia inactiva
Hypogymnia rugosa
Japewia subaurifera
Japewia tornoensis
Juncus drummondii
Juncus mertensiana
Jungermannia eucordifolia
Kaernefeltia merrillii
Kalmia microphylla
Kiaeria blytii
Kiaeria falcata
Lecanora cadubriae
Lepraria alpina
Lepraria membranacea
Leptarrhena pyrolifolia
Leptobryum pyriforme
Lobaria linita
Loiseleuria procumbens
Luetkea pectinata
Lupinus nootkatensis
Luzula parviflora
Luzula piperi
Marchantia alpina
Marsupella emarginata
Meesia uliginosa
Micranthes ferruginea
Micranthes lyallii
Parmeliopsis ambigua
Parnassia fimbriata
Pedicularis ornithorhynchus
Peltigera chionophila
Peltigera conspersa
Peltigera neopolydactyla
Pertusaria subdactylina
Petasites nivalis
Philonotis fontana var. *fontana*
Phyllodoce glanduliflora
Pilophorus nigricaulis
Pinguicula vulgaris
Placynthium nigrum
Platanthera dilitata
Platanthera stricta
Poa alpina
Poa leptocoma
Poa paucispicula

Polystichum lonchitis
Polytrichum juniperinum
Porpidia flavicunda
Preissia quadrata
Protopannaria pezizoides
Pseudoleskea atricha
Psoroma hypnorum
Ptilidium pulcherrimum
Ptychostomum pseudotriquetrum
Pyrenopsis haemaleella
Racomitrium lanuginosum
Radula complanata
Ranunculus nivalis
Ranunculus pygmaeus
Rhizocarpon geographicum
Rhizocarpon lecanorinum
Rubus pedatus
Sagina saginoides
Salix cf. *polaris*
Salix petrophila
Salix sitchensis
Sanguisorba stipularis
Sanionia uncinata
Sarmentypnum exannulatum
Saxifraga hyperborea
Saxifraga mertensiana
Schistochilopsis opacifolia
Sciurohypnum latifolium
Senecio triangularis
Sibbaldia procumbens
Solidago multiradiata
Solorina octospora
Sorbus sitchensis
Sphagnum compactum
Spilonema revertens
Steineropsis alaskana
Stereocaulon klondikense
Stereocaulon paschale
Stereocaulon symphycheilum
Tayloria lingulata
Thermutis velutina
Tofieldia pusilla
Tortella tortuosa
Trichophorum caespitosum
Trientalis arctica
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Umbilicaria muhlenbergii
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium ovalifolium
Vaccinium uliginosum
Vahlodea atropurpurea
Valeriana sitchensis
Veronica wormskjoldii
Vestergrenopsis elaeina
Viola langsdorfii
Xylographa soralifera

July 14, 2013, Site 2, Starting at 9V 434695 6221165

Abies lasiocarpa
Adiantum aleuticum
Agoseris aurantiaca ssp. *aurantiaca*
Alectoria sarmentosa
Alnus viridis ssp. sinuata
Anaphalis margaritacea
Aongstroemia longipes
Aquilegia formosa
Arabidopsis lyrata ssp. *kamchatica*
Arnica griscomii ssp. *frigida*
Arnica mollis
Artemisia norvegica
Aruncus dioica
Athyrium americanum
Athyrium filix-femina
Campanula lasiocarpa
Cardamine umbellata
Ceratodon purpureus
Cirsium edule
Cystopteris fragilis (erect, stiff, non-glandular form)
Dryopteris expansa
Dryopteris filix-mas
Elliottia pyroliflora
Elymus hirsutus
Epilobium angustifolium
Epilobium clavatum

Epilobium hornemannii ssp. *beringianum*
Epilobium lactiflorum
Epilobium latifolium
Equisetum arvense
Erythranthe lewisii
Galium triflorum
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Heuchera glabra
Hieracium triste
Imbribryum muhlenbeckii
Juncus mertensiana
Leptarrhena pyrolifolia
Leptodictyum riparium
Luetkea pectinata
Luzula parviflora
Marchantia alpina
Menziesia ferruginea
Micranthes ferruginea
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Mitella breweri
Mitella pentandra
Mnium spinulosum
Oplopanax horridus
Oxyria digyna
Pellia neesiana
Petasites nivalis
Philonotis fontana var. *americana*
Philonotis fontana var. *fontana*
Poa annua
Poa leptocoma
Pohlia atropurpurea
Pohlia cruda
Polystichum lonchitis
Populus trichocarpa
Preissia quadrata
Prenanthes alata
Pseudoleskea baileyi
Ranunculus nivalis
Ribes bracteosum
Ribes laxiflorum
Rubus spectabilis
Salix drummondiana
Salix petrophila
Salix sitchensis
Sanguisorba stipularis
Senecio triangularis
Stereocaulon paschale
Tellima grandiflora
Tetraplodon mnioides
Tiarella trifoliata var. *unifoliata*
Tsuga mertensiana
Vaccinium ovalifolium
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Viola glabella

July 14, 2013 - Site 3, Starting at 9V 435549 6219795

Abies lasiocarpa
Alectoria sarmentosa
Alnus viridis ssp. *sinuata*
Anaphalis margaritacea
Anemone parviflora
Antennaria alpina
Aquilegia formosa
Arabidopsis lyrata ssp. *kamchatica*
Arnica latifolia
Aruncus dioica
Athyrium americanum
Athyrium filix-femina
Blindia acuta
Campanula rotundifolia
Cardamine umbellata
Carex mertensii
Cystopteris fragilis (erect and stiff, non-glandular form)
Cystopteris fragilis (normal form)
Dryopteris expansa
Dryopteris filix-mas
Epilobium angustifolium
Epilobium clavatum
Epilobium latifolium
Epilobium luteum
Equisetum arvense
Galium triflorum

Gymnocarpium disjunctum
Gymnocarpium x *intermedium*
Heracleum lanatum
Heuchera glabra
Leptodictyum riparium
Lobaria linita
Luzula parviflora
Marchantia polymorpha
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Mitella breweri
Mnium spinulosum
Onchophorus virens
Osmorhiza purpurea
Oxyria digyna
Parnassia fimbriata
Peltigera praetextata
Petasites nivalis
Philonotis fontana var. *fontana*
Phleum alpinum
Poa annua
Poa compressa
Pogonatum urnigerum
Polystichum lonchitis
Populus trichocarpa
Preissia quadrata
Pseudoleskea baileyi
Ptilidium pulcherrimum
Ranunculus nivalis
Ranunculus uncinatus
Rhodiola integrifolia
Rhytidiopsis robusta
Ribes laxiflorum
Rubus spectabilis
Salix sitchensis
Sambucus racemosus
Sanguisorba stipularis
Sanionia uncinata
Saxifraga mertensiana
Saxifraga oppositifolia ssp. *smallii*
Stellaria crispa
Stellaria sitchensis
Tellima grandiflora
Tsuga mertensiana
Vaccinium ovalifolium
Valeriana sitchensis
Veronica wormskjoldii
Viola glabella

July 14, 2013, Site 4, Starting at 9V 435518 6218281

Abies lasiocarpa
Achillea millefolium var. *borealis*
Agoseris aurantiaca ssp. *aurantiaca*
Alnus viridis ssp. *sinuata*
Aquilegia formosa
Arabidopsis lyrata ssp. *kamchatica*
Aruncus dioica
Barbilophozia kunzeana
Calamagrostis canadensis
Cardamine umbellata
Carex lenticularis var. *lipocarpa*
Carex mertensii
Conocephalum conicum
Cystopteris fragilis (erect and stiff, non-glandular form)
Cystopteris fragilis (normal form)
Dichodontium pellucidum
Draba glabella
Dryopteris expansa
Dryopteris filix-mas
Epilobium angustifolium
Epilobium hornemannii ssp. *beringianum*
Epilobium lactiflorum
Epilobium latifolium
Epilobium luteum
Equisetum arvense
Galium triflorum
Geum macrophyllum var. *macrophyllum*
Gymnocarpium x *intermedium*
Heuchera glabra
Heuchera micrantha var. *diversifolia*
Leptodictyum riparium
Marchantia polymorpha
Micranthes ferruginea
Oxyria digyna
Pellia endivifolia
Penstemon serrulatus
Philonotis fontana var. *fontana*
Poa alpina

Poa annua
Poa glauca ssp. *rupicola*
Poa leptocoma
Poa palustris
Poa pratensis ssp. *pratensis*
Polygonum minimum
Polystichum lonchitis
Preissia quadrata
Prenanthes alata
Ptychostomum weigelii
Ranunculus nivalis
Ranunculus repens
Rhodiola integrifolia
Romanzoffia sitchensis
Salix drummondiana
Salix sitchensis
Sambucus racemosus
Schistidium rivulare
Sciurohypnum latifolium
Taraxacum officinale

July 14, 2013, Site 5, Starting at 9V 435269 6214256

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*
Alnus viridis ssp. *sinuata*
Anaphalis margaritacea
Aruncus dioica
Asterella gracilis
Athyrium americanum
Athyrium filix-femina
Bartramia ithyphylla
Blechnum spicant
Calamagrostis canadensis
Carex canescens ssp. *canescens*
Carex lenticularis var. *lipocarpa*
Carex mertensii
Carex sitchensis
Cerastium fontanum
Cladonia ochrochlora
Cladonia pyxidata
Clintonia uniflora
Cornus canadensis
Cornus unalaschcensis
Dicranum scoparium
Dryas drummondii
Elliottia pyroliflora
Epilobium angustifolium
Epilobium ciliatum
Equisetum arvense
Equisetum fluviatile
Equisetum variegatum
Galium triflorum
Gymnocarpium x *intermedium*
Hylocomium splendens
Hypogymnia rugosa
Isothecium stoloniferum
Juncus ensifolius var. *ensifolius*
Leptarrhena pyrolifolia
Listera cordata
Lobaria linita
Lobaria oregana
Lophozia ventricosa
Lysichiton americanus
Marchantia polymorpha
Menziesia ferruginea
Mycoblastus sanguinarius
Nephroma arcticum
Nephroma helveticum ssp. *sipeanum*
Niphotrichum canescens
Oplopanax horridus
Parmelia sulcata
Parmeliopsis hyperopta
Peltigera membranacea
Peltigera neopolydactyla
Petasites nivalis
Picea sitchensis
Platanthera stricta
Platismatia glauca
Platismatia lacunosa
Pleurozium schreiberi
Poa annua
Poa compressa
Poa palustris
Pogonatum urnigerum
Polystichum andersonii
Polytrichum commune
Populus trichocarpa
Preissia quadrata

Pseudoleskea baileyi
Ptilidium pulcherrimum
Rhizomnium magnifolium
Rhytidiopsis robusta
Rubus pedatus
Rubus spectabilis
Salix drummondiana
Salix sitchensis
Scapania bolanderi
Sorbus sitchensis
Sphaerophorus tuckermanii
Sphagnum squarrosum
Sphagnum teres
Stereocaulon intermedium
Stereocaulon paschale
Streptopus lanceolatus
Taraxacum officinale
Tiarella trifoliata var. *unifoliata*
Tsuga mertensiana
Vaccinium alaskense
Vaccinium ovalifolium

July 14, 2013, Site 6, Starting at 9V 435290 6213923

Abies lasiocarpa
Agrostis capillaris
Alectoria sarmentosa
Alnus viridis ssp. sinuata
Anaphalis margaritacea
Antitrichia curtipendula
Aruncus dioica
Athyrium filix-femina
Calamagrostis canadensis
Carex canescens ssp. *canescens*
Carex sitchensis
Cladonia cenotea
Cladonia cornuta ssp. *groenlandica*
Cladonia ecmocyna intermedia
Comarum palustre
Cryptogramma acrostichoides
Dicranum pallidisetum
Elliottia pyroliflora
Epilobium angustifolium
Epilobium latifolium
Gymnocarpium x *intermedium*
Hippuris vulgaris
Juncus filiformis
Lysichiton americanus
Menziesia ferruginea
Niphotrichum canescens
Nuphar variegatum
Onchophorus wahlenbergii
Oplopanax horridus
Orthilia secunda
Phegopteris connectilis
Picea sitchensis
Polytrichum juniperinum
Populus trichocarpa
Potamogeton gramineus
Pseudoleskea baileyi
Rubus spectabilis
Sagina procumbens
Salix sitchensis
Sanguisorba stipularis
Sparganium natans
Sphaerophorus tuckermanii
Sphagnum subnitens
Sphatnum riparium
Stereocaulon intermedium
Stereocaulon paschale
Tritomaria exsectiformis
Tsuga mertensiana
Vaccinium alaskense
Vaccinium ovalifolium
Viola palustris

August 15, 2013, Starting at 9V 434796, 6225029 (1,100 m) and Looping to the Southeast along the Ridgeline

Abies lasiocarpa
Adiantum aleuticum
Agoseris aurantiaca ssp. *aurantiaca*
Agrostis mertensii
Amphidium laponicum
Anastrophyllum minutum
Andreaea rupestris
Anthelia juratzkana
Arabidopsis lyrata ssp. *kamtchatica*
Artemisia norvegica
Asplenium viride
Aulacomnium palustre
Baeomyces rufus
Barbilophozia kunzeana
Bartramia ithyphylla
Bistorta vivipara
Blepharostoma trichophyllum
Botrychium crenulatum
Botrychium lunaria
Botrychium minganense
Botrychium pinnatum
Bucklandiella macounii
Buxbaumia aphylla
Caltha leptosepala var. *biflora*
Campanula lasiocarpa
Carex anthoxanthea
Carex enanderi
Carex nigricans
Carex phaeocephala
Cassiope mertensiana
Castilleja parviflora
Cephalozia catenulata
Cetraria islandica ssp. *crispiformis*
Cetraria islandica ssp. *islandica*
Chiloscyphus pallescens
Cinclidium stygium
Cirsium edule
Cladina arbuscula
Cladina mitis
Cladina rangiferina
Cladonia bellidiflora
Cladonia carneola
Cladonia cervicornis
Cladonia deformis
Cladonia ecmocyna ssp. *occidentalis*
Cladonia furcata
Cladonia gracilis ssp. *elongata*
Cladonia kanewskii
Cladonia macrophyllodes
Cladonia pleurota
Cladonia singularis
Cladonia suphurina
Cladonia uncialis
Codriophorus mollis
Cryptogramma achrostichoides
Dermatocarpon rivulorum
Dibaeis baeomyces? (sterile)
Dicranoweisia cirrata
Dicranum spadiceum
Diphasiastrum alpinum
Diphasiastrum sitchense
Distichium capillaceum
Draba lonchocarpa
Dryopteris filix-mas
Empetrum nigrum
Epilobium anagallidifolium
Epilobium clavatum
Epilobium hornemannii ssp. *behringianum*
Epilobium latifolium
Equisetum arvense
Erigeron nivalis
Erigeron peregrinus
Eriophorum angustifolium
Erythranthe lewisii
Euopsis pulvinata
Flavocetraria nivalis
Gymnomitrion concinnatum
Hieracium triste
Hippuris montana
Icmadophila ericetorum

Imbribryum muhlenbeckii
Juncus mertensii
Leptarrhena pyrolifolia
Lobaria linita
Luetkea pectinata
Luzula parviflora
Luzula wahlenbergii
Marchantia polymorpha
Marsupella emarginata
Meesia uliginosa
Micranthes ferruginea
Micranthes nelsoniana var. *porsildiana*
Micranthes tolmiei
Mitella pentandra
Mnium blyttii
Myosotis asiatica
Ochrolechia inaequatula
Orthilia secunda
Oxyria digyna
Paludella squarrosa
Palustriella falcata
Parnassia fimbriata
Pedicularis ornithorhynchus
Peltigera aphthosa
Peltigera conspersa s. lat.
Peltigera praetextata
Peltigera malacea
Peltigera venosa
Petasites nivalis
Phegopteris connectilis
Philonotis fontana
Phleum alpinum
Pilophorus nigricaulis
Pinguicula vulgaris
Placopsis gelida
Platanthera dilatata
Poa alpina
Pohlia cruda
Polystichum lonchitis
Polytrichum piliferum
Preissia quadrata
Protopannaria pezizoides
Psoroma hypnorum
Ptychostomum bimum
Rhodiola integrifolia
Rubus pedatus
Salix arctica
Salix nivalis
Salix petrophila
Salix sitchensis
Sanguisorba stipularis
Sanionia georgico-uncinata
Sarmentypnum exannulatum
Schistochilopsis opacifolia
Senecio triangularis
Solidago multiradiata
Solorina crocea
Sorbus sitchensis
Sphagnum capillifolium
Sphagnum rubellum
Sphagnum teres
Steineropsis alaskana
Stellaria borealis var. *sitchensis*
Stereocaulon alpinum
Stereocaulon paschale
Taraxacum alaskanum
Tayloria lingulata
Tofieldia pusilla
Tortella tortuosa
Trichophorum cespitosum
Tritomaria exsectiformis
Tsuga mertensiana
Vaccinium alaskaense
Vaccinium caespitosum
Vaccinium membranaceum
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Viola epipsila

August 16, 2013, Starting at 9V 434719, 6225543 (1,123 m) and Looping to the Northeast below the Glacier

Abies lasiocarpa
Amphidium laponicum
Andreaea rupestris
Antennaria monocephala ssp. *monocephala*
Anthelia julacea
Anthelia juratzkana
Arabidopsis lyrata ssp. *kamtchatica*
Arctoa fulvella
Arnica latifolia
Artemisia norvegica
Asterella lindenbergiana
Baeomyces carneus
Barbilophozia lycopodioides
Bartramia ithyphylla
Bistorta vivipara
Blepharostoma trichophyllum
Botrychium crenulatum
Botrychium lunaria
Botrychium minganense
Bryoria fuscescens
Bucklandiella sudetica
Calamagrostis canadensis ssp. *canadensis*
Caloplaca sorocarpa
Cardamine bellidifolia
Cardamine umbellata
Carex anthoxanthea
Carex enanderi
Carex garberi
Carex macrochaeta
Carex nigricans
Carex phaeocephala
Carex praeceptorum
Carex scirpoidea
Cassiope mertensiana
Cassiope tetragona
Castilleja miniata
Castilleja parviflora
Cetraria islandica ssp. *crispiformis*
Cetraria subalpina
Chiloscyphus rivularis
Cladonia carneola
Cladonia deformis
Cladonia gracilis ssp. *elongata*
Cladonia merochlorophaea
Conocephalum conicum
Cryptogramma achrostichoides
Dichodontium olympicum
Diphasiastrum alpinum
Diphasiastrum sitchense
Diplophyllum taxifolium
Distichium capillaceum
Distichium inclinatum
Dryas drummondii
Empetrum nigrum
Epilobium angustifolium
Epilobium clavatum
Epilobium hornemannii ssp. *behringianum*
Epilobium latifolium
Equisetum variegatum
Erigeron nivalis
Erigeron peregrinus
Fauria crista-galli
Fuscopannaria praetermissa group
Galium triflorum
Gymnocarpium disjunctum
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Gymnomitrion corallioideum
Gymnomitrion obtusifolium
Heuchera glabra
Hippuris montana
Huperzia haleakalae
Hygroamblystegium tenax
Hypnum bambergeri
Hypogymnia enteromorpha
Hypogymnia occidentalis
Juncus drummondii
Juncus mertensii
Juniperus communis
Lecanora chlarotera group

Leptarrhena pyrolifolia
Lobaria linita
Luetkea pectinata
Luzula spicata
Luzula wahlenbergii
Marsupella emarginata
Melanelia stygia
Micranthes nelsoniana var. *porsildiana*
Micranthes tolmiei
Mitella pentandra
Nephroma bellum
Nephroma helveticum ssp. *sipeanum*
Osmorhiza purpurea
Oxyria digyna
Parnassia fimbriata
Parnassia kotzebuei
Peltigera horizontalis
Peltigera occidentalis
Peltigera rufescens
Petasites nivalis
Philonotis fontana
Phyllodoce glanduliflora
Platanthera dilatata
Poa alpina
Poa arctica ssp. *lanata*
Poa pratensis ssp. *colpodea*
Pohlia ludwigii
Polystichum lonchitis
Preissia quadrata
Protopannaria pezizoides
Psoroma hypnorum
Psorula rufonigra
Ptychostomum turbinatum
Ptychostomum weigelii
Radula complanata
Ranunculus nivalis
Rhodiola integrifolia
Rhytidiadelphus subpinnatus
Rhytidium rugosum
Rubus pedatus
Sagina saginoides
Salix arctica
Salix cf. *polaris*
Sanguisorba stipularis
Sanionia uncinata
Sarmentypnum exannulatum
Sarmentypnum tundrae
Sauteria alpina
Saxifraga tricuspidata
Schaereria corticola
Senecio triangularis
Sibbaldia procumbens
Solorina crocea
Sorbus sitchensis
Sphagnum capillifolium
Sphagnum compactum
Sphagnum lindbergii
Sphagnum subnitens
Sphagnum tenellum
Spilonema revertens
Stellaria borealis var. *sitchensis*
Stereocaulon arenarium
Stereocaulon depressum
Stereocaulon glareosum
Stereocaulon grande
Stereocaulon nivale
Stereocaulon paschale
Stereocaulon tomentosum
Thamnolia vermicularis
Tiarella trifoliata var. *trifoliata*
Tortella tortuosa
Trapeliopsis granulosa
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Umbilicaria lambii
Valeriana sitchensis
Veronica wormskjoldii
Vestergrenopsis elaeina

August 17 a.m., 2013, Starting at 9V 433557, 6231317 (890 m) Heading Southeast to Small Summit (1,120 m) Directly above Road

Abies lasiocarpa
Anastrophyllum minutum
Anastrophyllum sphenoloboides
Amygdalaria panaeola
Andreaea nivalis
Aneura pinguis
Anthelia juratzkana
Athyrium alpestre
Baeomyces carneus
Baeomyces rufus
Bartramia ithyphylla
Bistorta vivipara
Bryum calobryoides
Campanula lasiocarpa
Carex anthoxanthea
Carex macrochaeta
Carex micropoda
Carex nigricans
Carex praeceptorum
Carex stylosa
Cassiope mertensiana
Castilleja parviflora
Cephalozia bicuspidata
Cetraria islandica ssp. *islandica*
Cladonia amaurocraea
Cladonia bellidiflora
Cladonia ecmocyna ssp. *intermedia*
Cladonia ecmocyna ssp. *occidentalis*
Cladonia gracilis ssp. *elongata*
Cladonia macrophyllodes
Cladonia pleurota
Cladonia singularis
Cladonia stricta
Cladonia wainioi
Claopodium bolanderi
Cystopteris fragilis (normal form)
Dermatocarpon rivulorum
Diphasiastrum sitchense
Diplophyllum taxifolium
Distichium capillaceum
Dryopteris expansa
Empetrum nigrum
Epilichen scabrosus
Epilobium clavatum
Epilobium latifolium
Euopsis pulvinata
Flavocetraria nivalis
Gymnocarpium dryopteris
Gymnocarpium jessoense
Gymnocarpium x *intermedium*
Gymnomitrion obtusifolium
Gymnomitrion pacificum
Harimanella stelleriana
Hieracium triste
Hierochloe alpina
Hippuris montana
Juncus mertensii
Kiaeria blyttii
Leptarrhena pyrolifolia
Leptogium gelatinosum
Listera cordata
Loeskypnum badium
Luetkea pectinata
Luzula parviflora
Luzula wahlenbergii
Marsupella emarginata
Micranthes tolmiei
Mitella pentandra
Nardia geoscyphus
Nephroma arcticum
Ochrolechia bryophaga
Oligotrichum paralellum
Parnassia fimbriata
Peltigera chionophila
Peltigera lepidophora
Peltigera neopolydactyla
Peltigera polydactylon
Peltigera malacea
Peltigera scabrosa
Peltigera venosa

Petasites nivalis
Pilophorus acicularis
Pilophorus nigricaulis
Pleurocladula albescens
Polyblastia cucurbitula
Polystichum lonchitis
Polytrichum commune
Polytrichum juniperinum
Protopannaria pezizoides
Psoroma hypnorum
Pterygiopsis concordatula?
Ptychostomum schleicheri
Ranunculus cooleyae
Ranunculus nivalis
Rhizomnium nudum
Rhytidiadelphus subpinnatus
Salix nivalis
Sanionia georgico-uncinata
Saxifraga hyperborea
Saxifraga tricuspidata
Scapania uliginosa
Schistochilopsis hyperborea
Schistochilopsis opacifolia
Schofieldia monticola
Stereocaulon arenarium
Stereocaulon botryosum
Stereocaulon depressum
Stereocaulon intermedium
Stereocaulon paschale
Syntrichia montana
Tortella tortuosa
Trapeliopsis granulosa
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria torrefacta
Umbilicaria muhlenbergii
Vaccinium alaskaense
Vaccinium membranaceum
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Vestergrenopsis elaeina
Warnstorfia fluitans

August 17 p.m., 2013, Starting at 9V 435650, 6219040 (743 m) Heading Southeast along Old Mining Roads

Abies lasiocarpa
Agrostis exarata
Agrostis stolonifera
Alnus viridis ssp. *sinuata*
Amblystegium tenax
Anastrophyllum minutum
Anaphalis margaritacea
Andreaea rupestris
Antennaria monocephala ssp. *monocephala*
Aquilegia formosa
Arnica latifolia
Artemisia norvegica
Aruncus dioica
Athyrium filix-femina var. *cyclosora*
Baeomyces carneus
Baeomyces rufus
Barbilophozia hatcheri
Bartramia ithyphylla
Bistorta vivipara
Bryoria trichodes ssp. *americana*
Bucklandiella sudetica
Calamagrostis canadensis ssp. *canadensis*
Campanula lasiocarpa
Carex enanderi
Carex kelloggii
Carex mertensii
Carex macloviana
Cephalozia bicuspidata
Cephalozia catenulata
Cetraria islandica ssp. *crispiformis*
Cetraria islandica ssp. *islandica*
Cladonia bellidiflora

Cladonia cenotea
Cladonia chlorophaea group
Cladonia deformis
Cladonia gracilis ssp. *elongata*
Cladonia suphurina
Cystopteris fragilis (normal form)
Dicranum scoparium
Diphasiastrum alpinum
Diphasiastrum sitchense
Dryopteris expansa
Elliottia pyroliflora
Epilobium angustifolium
Epilobium clavatum
Epilobium lactiflorum
Epilobium latifolium
Epilobium luteum
Epilobium x *treleasianum*
Equisetum arvense
Eriophorum angustifolium
Erythranthe guttata
Fauria crista-galli
Galium triflorum
Gemmabryum caespiticium
Geranium erianthum
Geum aleppicum
Gymnocarpium dryopteris
Gymnocarpium jessoense
Heracleum lanatum
Heuchera glabra
Hieracium triste
Hypogymnia rugosa
Japewia tornoensis
Juncus drummondii
Juncus mertensii
Leptarrhena pyrolifolia
Luetkea pectinata
Lupinus nootkatensis var. *nootkatensis*
Luzula parviflora
Marchantia polymorpha
Micranthes lyallii
Mycoblastus affinis
Nephroma arcticum
Oligotrichum paralellum
Orthilia secunda
Palustriella falcata
Peltigera polydactylon
Philonotis fontana
Phleum pratense
Platismatia glauca
Pleurocladula albescens
Poa arctica ssp. *lanata*
Pogonatum urnigerum
Pohlia filum
Prenanthes alata
Prosartes trachycarpa
Rhizomnium nudum
Ribes laxiflorum
Rubus pedatus
Rubus spectabilis
Sagina saginoides
Salix sitchensis
Sambucus racemosus
Sanguisorba stipularis
Sanionia uncinata
Saxifraga tricuspidata
Sciurohypnum latifolium
Senecio triangularis
Solorina crocea
Solorina spongiosa
Sorbus sitchensis
Sphaerophorus venerabilis
Sphagnum capillifolium
Sphagnum teres
Stellaria calycantha
Stereocaulon paschale
Straminergon stramineum
Tiarella trifoliata var. *trifoliata*
Trapeliopsis granulosa
Tritomaria quinquedentata
Tsuga mertensiana
Vaccinium alaskaense
Vaccinium caespitosum
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica beccabunga

Veronica wormskjoldii
Viola adunca

August 18, 2013, Starting at 9V 434366, 6228796 (978m) and Heading Northeast along Ridge to 1,285 m and then Looping to the Southeast

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*
Amblyodon dealbatus?
Amblystegium serpens
Anthelia julacea
Arnica latifolia
Artemisia norvegica
Athyrium alpestre
Aulacomnium palustre
Baeomyces rufus
Bartramia ithyphylla
Bistorta vivipara
Bucklandiella sudetica
Caltha leptosepala var. *biflora*
Campanula lasiocarpa
Campanula rotundifolia
Cardamine umbellata
Carex anthoxanthea
Carex enanderi
Carex kelloggii
Carex macrochaeta
Carex micropoda
Carex nigricans
Carex phaeocephala
Carex praeceptorum
Carex stylosa
Cassiope mertensiana
Cassiope tetragona
Castilleja parviflora
Cephaloziella spinigera
Cetraria islandica ssp. *crispiformis*
Cladonia bellidiflora
Cladonia chlorophaea group
Cladonia crispata ssp. *cetrariiformis*
Cladonia ecmocyna ssp. *intermedia*
Cladonia ecmocyna ssp. *occidentalis*
Cladonia gracilis ssp. *vulnerata*
Cladonia macrophyllodes
Cladonia pyxidata
Cladonia singularis
Cladopodiella fluitans
Codriophorus acicularis
Codriophorus mollis
Conostomum tetragonum
Cornus canadensis
Cryptogramma achrostichoides
Cystopteris fragilis (normal form)
Dermatocarpon rivulorum
Dibaeis baeomyces? (sterile)
Dicranum pallidisetum
Diphasiastrum alpinum
Diphasiastrum sitchense
Diplophyllum taxifolium
Distichium capillaceum
Ephebe sp. nov.
Epilobium latifolium
Epilobium luteum
Equisetum arvense
Equisetum variegatum
Erigeron peregrinus
Erythranthe lewisii
Harimanella stelleriana
Heuchera glabra
Hippuris montana
Huperzia arctica
Hygrohypnum smithii
Imbribryum muhlenbeckii
Jungermannia eucordifolia
Juniperus communis
Lecidoma demissum
Leptarrhena pyrolifolia
Lobaria linita
Luetkea pectinata
Lupinus nootkatensis var. *nootkatensis*
Lycopodium clavatum
Marsupella boeckii

Marsupella emarginata
Marsupella ustulata
Micranthes lyallii
Micranthes nelsoniana var. *porsildiana*
Micranthes tolmiei
Mitella pentandra
Mnium blyttii
Mnium lycopodioides
Nephroma arcticum
Ochrolechia grimmiae
Orthilia secunda
Palustriella falcata
Parnassia fimbriata
Peltigera neopolydactyla
Peltigera polydactylon
Peltigera venosa
Pertusaria oculata
Petasites nivalis
Philonotis fontana
Pilophorus clavatus
Pilophorus nigricaulis
Platanthera dilatata
Pohlia cruda
Polychidium muscicola
Polystichum lonchitis
Polytrichum juniperinum
Preissia quadrata
Protopannaria pezizoides
Psoroma hypnorum
Ptychostomum pallescens
Ptychostomum schleicheri
Ptychostomum weigelii
Ranunculus cooleyae
Ranunculus nivalis
Rhodiola integrifolia
Rhytidiopsis robusta
Salix maccalliana
Sanguisorba stipularis
Scapania irrigua
Senecio triangularis
Sibbaldia procumbens
Solidago multiradiata
Sorbus scopulina
Sphagnum centrale
Sphagnum cf. *arcticum*
Sphagnum compactum
Sphagnum girgensohnii
Sphagnum lindbergii
Sphagnum russowii
Sphagnum subfulvum
Sphagnum subnitens
Sphagnum subsecundum
Sphagnum tenellum
Sphagnum teres
Steineropsis alaskana
Stereocaulon botryosum
Stereocaulon depressum
Stereocaulon intermedium
Stereocaulon nivale
Stereocaulon paschale
Streptopus lanceolatus var. *curvipes*
Symphyotrichum foliaceum var. *apricum*
Symphyotrichum foliaceum var. *foliaceum*
Tofieldia pusilla
Tortella tortuosa
Umbilicaria havaasii
Umbilicaria muhlenbergii
Vaccinium alaskaense
Vaccinium caespitosum
Vaccinium vitis-idaea
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Vestergrenopsis elaeina

August 19, 2013, Starting at 9V 434753, 6228215 (948 m) Heading East-southeast above Road to 1,230 m then Looping toward the North Paralleling the Road

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*

Agrostis mertensii
Anastrophyllum minutum
Anaphalis margaritacea
Andreaea rupestris
Arnica latifolia
Artemisia norvegica
Asplenium viride
Athyrium alpestre
Bartramia ithyphylla
Bistorta vivipara
Botrychium crenulatum
Botrychium lunaria
Botrychium minganense
Botrychium pinnatum
Brachythecium frigidum
Calamagrostis canadensis ssp. *canadensis*
Caltha leptosepala var. *biflora*
Campanula lasiocarpa
Cardamine bellidifolia
Carex anthoxanthea
Carex brunnescens
Carex enanderi
Carex nigricans
Carex scirpoidea
Carex stylosa
Cassiope tetragona
Castilleja parviflora
Cladina mitis
Cladina rangiferina
Cladonia amaurocraea
Cladonia bellidiflora
Cladonia cervicornis
Cladonia coccifera
Cladonia crispata ssp. *cetrariiformis*
Cladonia ecmocyna ssp. *intermedia*
Cladonia ecmocyna ssp. *occidentalis*
Cladonia gracilis ssp. *elongata*
Cladonia macrophylla
Cladonia macrophyllodes
Cladonia pseudalcicornis
Cladonia singularis
Cladonia uncialis
Claopodium bolanderi
Cratoneuron filicinum
Cryptogramma achrostichoides
Dichodontium pellucidum
Dicranum fuscescens
Diphasiastrum alpinum
Diphasiastrum sitchense
Diplophyllum taxifolium
Distichium capillaceum
Drepanocladus aduncus
Empetrum nigrum
Epilobium clavatum
Epilobium hornemannii ssp. *behringianum*
Epilobium lactiflorum
Epilobium latifolium
Epilobium luteum
Equisetum arvense
Erigeron peregrinus
Erythranthe lewisii
Euopsis pulvinata
Eurynchium pulchellum
Fauria crista-galli
Gentiana platypetala
Grimmia sessitana
Gymnomitrion corallioideum
Gymnomitrion obtusifolium
Hieracium gracile
Hippuris montana
Huperzia haleakalae
Hydrothyria venosa s. lat.
Icmadophila ericetorum
Juncus drummondii
Juncus mertensii
Juniperus communis
Leptarrhena pyrolifolia
Listera cordata
Lobaria linita
Luetkea pectinata
Luzula parviflora
Luzula wahlenbergii
Lycopodium clavatum
Marchantia polymorpha
Marsupella emarginata
Massalongia carnosa

Micranthes nelsoniana var. *porsildiana*
Mitella pentandra
Mnium lycopodioides
Moerckia blyttii
Mylia taylorii
Myosotis asiatica
Nardia scalaris
Nephroma bellum
Niphotrichum muticum
Oligotrichum paralellum
Orthilia secunda
Oxyria digyna
Peltigera collina
Peltigera neopolydactyla
Petasites nivalis
Phaeophyscia orbicularis
Phegopteris connectilis
Philonotis capillaris
Philonotis fontana
Placopsis gelida
Placynthium nigrum
Platanthera dilatata
Platydictya jungermannioides
Pleurozium schreberi
Poa alpina
Poa arctica ssp. *lanata*
Pohlia nutans
Polystichum lonchitis
Polytrichastrum alpinum
Polytrichum juniperinum
Preissia quadrata
Protopannaria pezizoides
Psoroma hypnorum
Ptilidium californicum
Ptychostomum pseudotriquetrum
Ptychostomum weigelii
Ramboldia cinnabarina
Ranunculus occidentalis var. *hexasepalus*
Rhodiola integrifolia
Rhytidiadelphus subpinnatus
Ribes laxiflorum
Rubus pedatus
Rubus spectabilis
Salix arctica
Sarmentypnum exannulatum
Saxifraga tricuspidata
Scapania irrigua
Scapania obcordata
Schistochilopsis opacifolia
Sciurohypnum latifolium
Senecio triangularis
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Solorina crocea
Sorbus scopulina
Sphagnum fimbriatum
Sphagnum quinquefarium
Sphagnum rubellum
Sphagnum squarrosum
Sphagnum tenellum
Stellaria borealis var. *sitchensis*
Stereocaulon botryosum
Stereocaulon glareosum
Stereocaulon intermedium
Stereocaulon klondikense
Stereocaulon paschale
Stereocaulon tomentosum
Thamnolia vermicularis
Trapeliopsis granulosa
Trichophorum cespitosum
Trisetum spicatum
Tritomaria quinquedentata
Tsuga mertensiana
Umbillicaria angulata
Umbilicaria muhlenbergii
Vaccinium caespitosum
Vaccinium uliginosum
Vaccinium vitis-idaea
Vahlodea atropurpurea
Valeriana sitchensis
Veratrum viride
Veronica wormskjoldii
Vestergrenopsis elaeina
Viola adunca
Xanthoria elegans

August 20, 2013, Starting at 9V 433554, 6231315 (825 m) Heading East up Prominent Valley before Ascending Ridge to the North (1,370 m) and Looping Back towards the Gate

Abies lasiocarpa
Agoseris aurantiaca ssp. *aurantiaca*
Agrostis mertensii
Alectoria ochroleuca
Amblyodon dealbatus
Anastrophyllum minutum
Anemone multifida ssp. *saxicola*
Amygdalaria panaeola
Andreaea rupestris
Andreaea nivalis
Antennaria alpina
Anthelia julacea
Anthelia juratzkana
Arnica latifolia
Artemisia norvegica
Athyrium alpestre
Bartramia ithyphylla
Bistorta vivipara
Blepharostoma trichophyllum
Botrychium minganense
Bryoria fuscescens
Bucklandiella macounii
Caltha leptosepala var. *biflora*
Calypogeia integristipula
Campanula lasiocarpa
Carex enanderi
Carex garberi
Carex macrochaeta
Carex nigricans
Carex phaeocephala
Carex scirpoidea
Cassiope mertensiana
Cassiope tetragona
Castilleja parviflora
Cephalozia bicuspidata
Cetraria hepatizon
Cetraria islandica ssp. *crispiformis*
Cetraria nigricans
Chiloscyphus polyanthos
Cladina arbuscula
Cladina rangiferina
Cladina stellaris
Cladonia bellidiflora
Cladonia cariosa group
Cladonia carneola
Cladonia furcata
Cladonia gracilis ssp. *elongata*
Cladonia macrophyllodes
Cladonia pseudalcicornis
Cladonia suphurina
Cladopodiella fluitans
Collema ceraniscum
Conostomum tetragonum
Cryptogramma achrostichoides
Cystopteris fragilis (normal form)
Dermatocarpon rivulorum
Dicranum muhlenbeckii
Dicranum spadiceum
Diphasiastrum alpinum
Diphasiastrum sitchense
Diplophyllum taxifolium
Ditrichum cf. *ambiguum*
Drepanocladus polygamus
Empetrum nigrum
Epilobium clavatum
Epilobium latifolium
Epilobium leptocarpum
Equisetum arvense
Erythranthe lewisii
Euopsis pulvinata
Flavocetraria nivalis
Fuscopannaria praetermissa group
Gymnocarpium dryopteris
Gymnocarpium jessoense
Gymnomitrion corallioideum
Hieracium triste
Huperzia haleakalae
Hydrothyria venosa s. lat.
Hygrohypnum ochraceum
Japewia tornoensis

Juncus mertensii
Jungermannia exsertifolia
Kaernefeltia merrillii
Kiaeria starkei
Lecidoma demissum
Leptarrhena pyrolifolia
Luetkea pectinata
Luzula parviflora
Luzula spicata
Luzula wahlenbergii
Marsupella ustulata
Melanelia sorediata
Micranthes nelsoniana var. *carlottae*
Mitella pentandra
Moerckia blyttii
Nardia scalaris
Niphotrichum muticum
Ochrolechia szatalaensis
Orthilia secunda
Oxyria digyna
Parmeloipsis hyperopta
Peltigera chionophila
Peltigera conspersa s. lat.
Peltigera leucophlebia
Peltigera occidentalis
Peltigera polydactylon
Peltigera venosa
Petasites nivalis
Philonotis fontana
Phyllodoce glanduliflora
Platanthera dilatata
Pohlia lescuriana
Polystichum lonchitis
Potentilla hyparctica
Protopannaria pezizoides
Pseudoleskea atricha
Pseudoleskea incurvata
Psoroma hypnorum
Ptychostomum weigelii
Ranunculus cooleyae
Ranunculus nivalis
Rhizomnium nudum
Rhizomnium pseudopunctatum
Rhodiola integrifolia
Rhytidiopsis robusta
Romanzoffia sitchensis
Salix arctica
Salix petrophila
Sanguisorba stipularis
Sarmentypnum exannulatum
Saxifraga tricuspidata
Schistochilopsis hyperborea
Sciurohypnum latifolium
Senecio triangularis
Sibbaldia procumbens
Silene acaulis
Solidago multiradiata
Sorbus sitchensis
Sphagnum compactum
Sphagnum lindbergii
Sphagnum tenellum
Stereocaulon alpinum
Stereocaulon glareosum
Stereocaulon klondikense
Stereocaulon nivale
Stereocaulon paschale
Streptopus lanceolatus var. *curvipes*
Taraxacum alaskanum
Thamnolia vermicularis
Tiarella trifoliata var. *unifoliata*
Tortella fragilis
Trapeliopsis granulosa
Tritomaria quinquedentata
Tsuga mertensiana
Umbilicaria hyperborea
Umbilicaria torrefacta
Umbilicaria muhlenbergii
Vaccinium alaskaense
Vahlodea atropurpurea
Veronica wormskjoldii
Vestergrenopsis isidiata
Woodsia alpina

Appendix 8-4

Locations of the Rare Plants and Lichens Observed in the 2012 – 2013 Surveys

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Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Lichen	*Vahliella leucophaea*	New for BC, rare			Yes	No	N/A	N/A	2012-07-12		448199	6250036	9	GPS unit
Lichen	*Bryocaulon hyperboreum*	New for BC, rare			Yes	No	N/A	N/A	2012-07-16		426484	6259310	9	GPS unit
Lichen	*Leptogium imbricatum*	New for BC, rare			No	Yes	*Björk 27944*	UBC	2012-07-16		425173	6260416	9	GPS unit
Lichen	*Bryocaulon hyperboreum*	New for BC, rare			No	Yes	*Björk 28908, 28931*	UBC	2012-08-31		425602	6259768	9	GPS unit
Lichen	*Bryocaulon hyperboreum*	New for BC, rare			No	Yes	*Björk 28908, 28931*	UBC	2012-08-31		426484	6259310	9	GPS unit
Vascular plant	*Ranunculus occidentalis* var. *hexasepalus*	Not ranked, but rare; to be added to the Blue or Red list in BC in 2013			Yes	Yes	*Björk 27879*	UBC	2012-09-02		427146	6259515	9	GPS unit
Moss	*Mielichhoferia elongata*	New for BC, rare			Yes	Yes	*Björk 27691*	UBC	2012-07-14		439176	6251471	9	GPS unit
Vascular plant	*Draba* sp. nov.	Rare new species			Yes	Yes	*Björk 26610*	UBC	2012-07-12		448199	6250036	9	GPS unit
Lichen	*Collema* sp. nov.	Rare new species			Yes	Yes	*Björk 27693*	UBC	2012-07-14		448262	6250047	9	GPS unit
Vascular plant	*Draba* sp. nov.	Rare new species			Yes	Yes	*Björk 26697*	UBC	2012-07-16		426884	6260030	9	GPS unit
Lichen	*Phaeophyscia cf nigricans*	Rare new species			Yes	No	N/A	N/A	2012-07-16		425751	6259698	9	GPS unit
Vascular plant	*Draba* sp. nov.	Rare new species			No	No	N/A	N/A	2012-08-31		426496	6259759	9	GPS unit
Vascular plant	*Carex* sp. nov. (aff. *Carex atrata*)	Rare new species			No	Yes	*Björk 27869*	UBC	2012-09-01		426390	6259970	9	GPS unit
Vascular plant	*Draba* sp. nov.	Rare new species			Yes	Yes	*Björk 27853*	UBC	2012-09-01		426355	6259982	9	GPS unit
Lichen	*Umbilicaria* sp. nov.	Rare new species			Yes	Yes	*Björk 28979*	UBC	2012-09-01		425877	6260078	9	GPS unit
Vascular plant	*Antennaria howellii x alpina*	Rare new species			Yes	Yes	*Björk 27878*	UBC	2012-09-02		427146	6259515	9	GPS unit
Lichen	*Phaeophyscia cf nigricans*	Rare new species			Yes	No	N/A	N/A	2012-09-02		426584	6260135	9	GPS unit
Vascular plant	*Micranthes nelsoniana* var. nov.	Rare new variety			Yes	Yes	*Björk 26713*	UBC	2012-07-17		457388	6263225	9	GPS unit
Lichen	*Fuscopannaria cheiroloba*	Not listed, rare			Yes	Yes	*Björk 27685*	UBC	2012-07-14		448273	6250105	9	GPS unit
Lichen	*Cladonia coccifera*		S1	Red-listed	Yes	No	N/A	N/A	2012-07-12		448199	6250036	9	GPS unit
Lichen	*Collema crispum*		S1	Red-listed	No	No	N/A	N/A	2012-07-12		448199	6250036	9	GPS unit
Lichen	*Cladonia coccifera*		S1	Red-listed	No	Yes	*Björk 27915*	UBC	2012-07-14		448142	6249979	9	GPS unit
Lichen	*Collema crispum*		S1	Red-listed	Yes	No	N/A	N/A	2012-07-14		448142	6249979	9	GPS unit
Lichen	*Leptogium cyanescens*		S1	Red-listed	Yes	No	N/A	N/A	2012-07-14		448142	6249979	9	GPS unit
Lichen	*Cladonia coccifera*		S1	Red-listed	No	Yes	*Björk 27995*	UBC	2012-07-16		425226	6260294	9	GPS unit
Lichen	*Collema ceraniscum*		S1	Red-listed	Yes	No	N/A	N/A	2012-07-16		423732	6263275	9	GPS unit
Lichen	*Parmelia skultii*		S1	Red-listed	No	Yes	*Björk 28020*	UBC	2012-07-16		424337	6263022	9	GPS unit
Lichen	*Stereocaulon depressum*		S1	Red-listed	No	Yes	*Björk 28012*	UBC	2012-07-16		423732	6263275	9	GPS unit
Lichen	*Collema ceraniscum*		S1	Red-listed	No	Yes	*Björk 28976*	UBC	2012-09-01		425751	6257698	9	GPS unit
Lichen	*Stereocaulon depressum*		S1	Red-listed	Yes	No	N/A	N/A	2012-09-02		426883	6260020	9	GPS unit
Lichen	*Lempholemma intricatum*		S1S2	Red-listed	No	Yes	*Björk 28093* (sub *Psora tuckermanii*)	UBC	2012-07-14		448142	6249979	9	GPS unit
Lichen	*Lempholemma intricatum*		S1S2	Red-listed	Yes	Yes	*Björk 28037*	UBC	2012-07-16		425751	6259698	9	GPS unit
Lichen	*Stereocaulon symphycheilum*		S1S2	Red-listed	No	Yes	*Björk 27785*	UBC	2012-07-16		426433	6259675	9	GPS unit
Moss	*Psilopilum cavifolium*		S1S2	Red-listed	Yes	Yes	*Björk 28914*	UBC	2012-08-31		426496	6259759	9	GPS unit
Lichen	*Stereocaulon symphycheilum*		S1S2	Red-listed	No	Yes	*Björk 28922*	UBC	2012-08-31		426390	6259970	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Lichen	*Vahliella leucophaea*	Crevices of cliffs and on ledge, valley elevation	About 10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Bryocaulon hyperboreum*	Over moss and gravel on windblown alpine ridgetops	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Leptogium imbricatum*	On ledge of slightly seepy cliff, alpine	1 patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Bryocaulon hyperboreum*	Over moss and gravel on windblown alpine ridgetops	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Bryocaulon hyperboreum*	Over moss and gravel on windblown alpine ridgetops	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Ranunculus occidentalis* var. *hexasepalus*	On outwash from creek and waterfalls at cliff base, alluvial fan at lake shore and immediately adjacent slopes	5000-10,000 genets	See Appendix E-2		See Appendix E-2, map of polygon marking bounds of population	(approx. centre of population)
Moss	*Mielichhoferia elongata*	In runnels on nearly bare gossen (iron rich rock) outcrop, valley elevation near terminus of glacier	1 composite patch with 10,000's of leaf rosettes, probably all one genet	About 5 m squared	10	Map as point with a 10 m radial buffer	
Vascular plant	*Draba* sp. nov.	On cliff ledges and crevices, valley elevations	50-100 plants	5 x 5 m	10	Map as point with a 10 m radial buffer	
Lichen	*Collema* sp. nov.	Over cobbles in back channel of river, periodically flooded	1000-5000 thalli	ca. 5 x 20 m		Map as point with an elliptic buffer 20 m E-W and 5 m N-S corresponding to channel (visible in aerial photos as treeless area)	
Vascular plant	*Draba* sp. nov.	Crevices of short cliff in alpine tundra	Ca. 50 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Phaeophyscia cf nigricans*	Saxicolous, on seepy underhangs of cliff faces, lower elevation and alpine	Ca. 25 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba* sp. nov.	Crevices of short cliff, alpine	50-100 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex* sp. nov. (aff. *Carex atrata*)	Moist soil in alpine tundra	Unknown, at least 100 stems	Unknown; diffuse population, bounds of population not found	10	Map as point with a 10 m radial buffer	
Vascular plant	*Draba* sp. nov.	On ledges and in crevices of seepy cliff	Ca. 200-300 genets	10 x 10 m	15	Map as point with a 15 m radial buffer	
Lichen	*Umbilicaria* sp. nov.	Saxicolous, rock pinnacles, windblown alpine ridge	1 large patch of about 100 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Antennaria howellii x alpina*	Wet alpine meadow, alluvial fan of creek where it enters alpine lake	1 patch of ca. 200 ramets, probably all one genet	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Phaeophyscia cf nigricans*	Saxicolous, cliff face, alpine	10-20 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Micranthes nelsoniana* var. nov.	Forest/marsh ecotone in moderate shade, moist soil, upper montane (the other populations of this taxon occur in subalpine meadows)	Ca. 50 genets	ca. 5 x 5 m	10	Map as point with a 10 m radial buffer	
Lichen	*Fuscopannaria cheiroloba*	Cliff ledge by river back channel, valley elevation	1 thallus (searched all accessible habitat in area for more)	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia coccifera*	On ledge of cliffs, valley elevation	1 small patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Collema crispum*	Cliff face, where seepy, valley elevation	1 small patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia coccifera*	Cliff ledge at valley elevations	1 patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Collema crispum*	On cliff ledge, valley elevation	1 patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Leptogium cyanescens*	On seepy cliff face, valley elevation	ca. 20 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia coccifera*	On mossy cliff ledge, slightly seepy, in rocky alpine tundra	Ca. 10 patches, each with at least one podetium.	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Collema ceraniscum*	On ledges of seepy cliffs, alpine	1 patch observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Parmelia skultii*	Over moss on gravel, windblown alpine ridgetop	1 composite patch, probably all one genet	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon depressum*	On rock faces, cliffy terrain on windblown alpine ridge	2 large thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Collema ceraniscum*	Over moss on seepy cliff ledge	5-10 clumps	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon depressum*	Directly attached to rock face of dry or slightly seepy cliff, alpine	1 thallus observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Lempholemma intricatum*	On seepy cliff face, valley elevation	ca. 100 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Lempholemma intricatum*	Saxicolous, on seepy underhangs of cliff faces, lower elevation and alpine	Ca. 50 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon symphycheilum*	On cliffs, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Psilopilum cavifolium*	On thin soil at base of short cliff in rocky alpine tundra	Unknown, at least 20 ramets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon symphycheilum*	On rock faces in alpine tundra	50-100 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Lichen	*Stereocaulon symphycheilum*		S1S2	Red-listed	No	Yes	*Björk 28922*	UBC	2012-08-31		426433	6259675	9	GPS unit
Lichen	*Lempholemma intricatum*		S1S2	Red-listed	No	Yes	*Björk 28993*	UBC	2012-09-01		425329	6260147	9	GPS unit
Moss	*Plagiobryum demissum*		S1S2	Red-listed	No	Yes	*Björk 29012*	UBC	2012-09-01		426390	6259970	9	GPS unit
Lichen	*Stereocaulon symphycheilum*		S1S2	Red-listed	No	No	N/A	N/A	2012-09-01		425751	6259698	9	GPS unit
Moss	*Bryum calobryoides*		S1S2	Red-listed	No	Yes	*Björk 29017*	UBC	2012-09-02		426584	6260135	9	GPS unit
Moss	*Psilopilum cavifolium*		S1S2	Red-listed	No	Yes	*Björk 29023*	UBC	2012-09-02		426991	6259859	9	GPS unit
Moss	*Sphagnum annulatum*		S1S2	Red-listed	No	Yes	*Björk 29058, 29060, 29061, 29062*	UBC	2012-09-03		454901	6262764	9	GPS unit
Vascular plant	*Epilobium davuricum*		S1S3	Red-listed	Yes	Yes	*Björk 26633*	UBC	2012-07-13		452837	6262561	9	GPS unit
Lichen	*Collema cristatum var. marginale*		S2	Red-listed	Yes	No	N/A	N/A	2012-07-12		448199	6250036	9	GPS unit
Lichen	*Stereocaulon botryosum*		S2	Red-listed	Yes	Yes	*Björk 27737*	UBC	2012-07-14		447351	6249744	9	GPS unit
Lichen	*Stereocaulon botryosum*		S2	Red-listed	Yes	Yes	*Björk 28016*	UBC	2012-07-16		425226	6260294	9	GPS unit
Moss	*Pohlia cardotii*		S2	Red-listed	Yes	Yes	*Björk 29578*	UBC	2012-08-31		426911	6259164	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	Yes	No	N/A	N/A	2012-07-12		448199	6250036	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-13		426991	6259859	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	Yes	Yes	*Björk 27656*	UBC	2012-07-13		439724	6254035	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-14		448273	6250105	9	GPS unit
Vascular plant	*Epilobium hornemannii ssp. behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-14		446421	6249628	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	Yes	No	N/A	N/A	2012-07-15		455491	6260423	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-15		456475	6260444	9	GPS unit
Vascular plant	*Draba ruaxes*		S2S3	Blue-listed	Yes	Yes	*Björk 26671, 26683*	UBC	2012-07-15		see comment		9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-15		455470	6260405	9	GPS unit
Vascular plant	*Polemonium elegans*		S2S3	Blue-listed	Yes	Yes	*Björk 26670*	UBC	2012-07-15		see comment		9	GPS unit
Lichen	*Stereocaulon glareosum*		S2S3	Blue-listed	Yes	Yes	*Björk 27930*	UBC	2012-07-15		424337	6263022	9	GPS unit
Lichen	*Cladonia subfurcata*		S2S3	Blue-listed	No	Yes	*Björk 27984*	UBC	2012-07-16		425243	6260282	9	GPS unit
Lichen	*Collema glebulentum*		S2S3	Blue-listed	No	Yes	*Björk 27798*	UBC	2012-07-16		425173	6260416	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-16		421922	6263256	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	No	No	N/A	N/A	2012-07-16		425181	6260388	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	Yes	*Björk 26702*	UBC	2012-07-16		421922	6263256	9	GPS unit
Lichen	*Nodobryoria subdivergens*		S2S3	Blue-listed	Yes	Yes	*Björk 27778*	UBC	2012-07-16		425181	6260388	9	GPS unit
Lichen	*Solorina bispora*		S2S3	Blue-listed	Yes	Yes	*Björk 28024*	UBC	2012-07-16		423732	6263275	9	GPS unit
Lichen	*Solorina bispora*		S2S3	Blue-listed	Yes	Yes	*Björk 27964*	UBC	2012-07-16		426390	6259970	9	GPS unit
Lichen	*Stereocaulon glareosum*		S2S3	Blue-listed	No	Yes	*Björk 28022*	UBC	2012-07-16		457994	6258550	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	Yes	Yes	*Björk 27799*	UBC	2012-07-16		425181	6260388	9	GPS unit
Vascular plant	*Woodsia alpina*		S2S3	Blue-listed	Yes	Yes	*Björk 26691*	UBC	2012-07-16		425226	6260294	9	GPS unit
Lichen	*Arctoparmelia incurva*		S2S3	Blue-listed	No	No	N/A	N/A	2012-08-31		426484	6259310	9	GPS unit
Lichen	*Cladonia subfurcata*		S2S3	Blue-listed	No	No	N/A	N/A	2012-08-31		426474	6259351	9	GPS unit
Lichen	*Sphaerophorus fragilis*		S2S3	Blue-listed	Yes	Yes	*Björk 28924*	UBC	2012-08-31		426484	6259310	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Lichen	*Stereocaulon symphycheilum*	On rock faces in alpine tundra	50-100 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Lempholemma intricatum*	On seepy cliff face	Unknown number of thalli, but probably at least 100	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Plagiobryum demissum*	Among other bryophytes at base of seepy cliff, alpine	1 patch of about 100 stems	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon symphycheilum*	On rock faces in alpine tundra	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Bryum calobryoides*	Among other mosses on cliff ledge, alpine	Unknown, collected incidentally	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Psilopilum cavifolium*	Moist, mossy ground among boulders near small creek, alpine	Ca. 50 ramets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Sphagnum annulatum*	Sloped fen with stunted conifers, upper montane	Unknown	Unknown	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium davuricum*	On wet, densely moss-covered ground in marsh, lower elevation	100-200 genets	10 x 10 m	15	Map as point with a 15 m radial buffer	
Lichen	*Collema cristatum var. marginale*	Cliff face, where seepy, valley elevation	1 small patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon botryosum*	On cliff ledges, valley elevation	20-30 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon botryosum*	On mossy cliff ledge, slightly seepy, in rocky alpine tundra	10-20 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Pohlia cardotii*	On moist ground in alpine heath	Ca. 300 ramets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba glabella*	On ledge of cliffs, valley elevation	1 plant observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia pseudalcicornis*	Subalpine and alpine heaths	3 patches observed, each of about 20-50 squamules; few podetia present	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia pseudalcicornis*	Subalpine and alpine heaths	1 patch observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba glabella*	On cliff ledge by river back channel, valley elevation	50-70 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii ssp. behringianum*	On packed mud of small beaver dam, valley elevation	4 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia pseudalcicornis*	On moss at base of stable scree in lower alpine	1 patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba glabella*	On short cliffs shortly downslope from ridgecrest, above zone of dense alpine vegetation and the more stable rock of the ridgetop	ca. 15 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba ruaxes*	Scree and small rock outcrops/short cliffs shortly downslope from ridgecrest, above zone of dense alpine vegetation and the more stable rock of the ridgetop	2000-3000 genets estimated	See Appendix E-1		See Appendix E-1, map of polygon marking bounds of population	South, west and southwest facing slopes along ridge between the points 458016 6258631 and 455476 6260618 (see attached Google Earth image Appendix E)
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Along small creek in slide-alder, avelanche track in upper subalpine	ca. 20 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Polemonium elegans*	Scree shortly downslope from ridgecrest, above zone of dense alpine vegetation and the more stable rock of the ridgetop	5000-10000 genets	See Appendix E-1		See Appendix E-1, map of polygon marking bounds of population	South, west and southwest facing slopes along ridge between the points 458016 6258631 and 455476 6260618 (see attached Google Earth image Appendix E)
Lichen	*Stereocaulon glareosum*	Gravelly ground on windblown alpine ridge	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia subfurcata*	Terricolous in alpine tundra	Patchy, unknown number of thalli tangled with each other and with other Cladonia spp.	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Collema glebulentum*	Cliff face, where seepy, alpine	Ca. 30-40 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba glabella*	On cliff ledge, alpine tundra	5-10 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Draba glabella*	On cliff ledge, alpine tundra	10-20 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Moist soil among boulders in cliffy ravine, alpine	Ca. 15 genets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Nodobryoria subdivergens*	Over moss and gravel at cliff top, windblown alpine ridgetop	50-100 thalli	ca. 5 x 5 m	10	Map as point with a 10 m radial buffer	
Lichen	*Solorina bispora*	On ledges of seepy cliffs, alpine	1 patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Solorina bispora*	On ledges of seepy cliffs, alpine	1 patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon glareosum*	On gritty soil in rocky alpine tundra	50-100 patches	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Vestergrenopsis elaeina*	On cliff faces, alpine tundra	Ca. 50 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Woodsia alpina*	Mossy cliff ledges and crevices, alpine	Ca. 30 genets	ca. 5 x 5 m	10	Map as point with a 10 m radial buffer	
Lichen	*Arctoparmelia incurva*	Saxicolous on rock faces, on windblown alpine ridgetops	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia subfurcata*	Over moss on rocky tundra, windblown alpine ridge	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Sphaerophorus fragilis*	On friable rock of pinnacles, windblown, rocky alpine tundra	20-30 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Moss	*Sphagnum aongstroemii*		S2S3	Blue-listed	Yes	No	N/A	N/A	2012-08-31		426928	6259146	9	GPS unit
Lichen	*Bryoria nitidula*		S2S3	Blue-listed	No	Yes	*Björk 28975*	UBC	2012-09-01		426484	6259310	9	GPS unit
Lichen	*Cladonia subfurcata*		S2S3	Blue-listed	No	No	N/A	N/A	2012-09-01		426463	6259667	9	GPS unit
Lichen	*Solorina bispora*		S2S3	Blue-listed	No	Yes	*Björk 28997*	UBC	2012-09-01		425175	6260398	9	GPS unit
Lichen	*Sphaerophorus fragilis*		S2S3	Blue-listed	No	Yes	*Björk 28982*	UBC	2012-09-01		425877	6260078	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	No	No	N/A	N/A	2012-09-02		426991	6259859	9	GPS unit
Vascular plant	*Epilobium hornemannii ssp. behringianum*		S2S3	Blue-listed	Yes	No	N/A	N/A	2012-09-02		426991	6259859	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	Yes	No	N/A	N/A	2012-09-02		426883	6260020	9	GPS unit
Vascular plant	*Epilobium leptocarpum*		S2S3	Blue-listed	No	Yes	*Björk 27890*	UBC	2012-09-03		454871	6262677	9	GPS unit
Vascular plant	*Carex rostrata x utriculata*		S2S3	Blue-listed	Yes	Yes	*Björk 29159*	UBC	2012-07-13		452837	6262561	9	GPS unit
Vascular plant	*Carex rostrata x utriculata*		S2S3	Blue-listed	Yes	No	N/A	N/A	2012-07-14		438855	6251553	9	GPS unit
Lichen	*Dermatocarpon leptophyllodes*		S2S4	Blue-listed	Yes	No	N/A	N/A	2012-07-12		447813	6249804	9	GPS unit
Lichen	*Dermatocarpon leptophyllodes*		S2S4	Blue-listed	No	No	N/A	N/A	2012-07-14		448142	6249979	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	Yes	No	N/A	N/A	2012-07-12		447351	6249744	9	GPS unit
Moss	*Tomentypnum falcifolium*		S3	Blue-listed	No	No	N/A	N/A	2012-07-13		452837	6262561	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	No	No	N/A	N/A	2012-07-14		448325	6249730	9	GPS unit
Lichen	*Cetraria nigricans*		S3	Blue-listed	No	No	N/A	N/A	2012-07-15		455506	6260422	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	No	Yes	*Björk 27751*	UBC	2012-07-15		455506	6260422	9	GPS unit
Lichen	*Cetraria delisei*		S3	Blue-listed	No	Yes	*Björk 27817*	UBC	2012-07-16		425229	6260618	9	GPS unit
Lichen	*Cetraria nigricans*		S3	Blue-listed	No	Yes	*Björk 27787*	UBC	2012-07-16		424336	6263039	9	GPS unit
Lichen	*Cetraria delisei*		S3	Blue-listed	No	Yes	*Björk 27817* (sub *Cetraria delisei*)	UBC	2012-07-16		425229	6260618	9	GPS unit
Lichen	*Allantoparmelia almquistii*		S3	Blue-listed	Yes	Yes	*Björk 28926*	UBC	2012-08-31		426484	6259310	9	GPS unit
Lichen	*Cetraria nigricans*		S3	Blue-listed	Yes	No	N/A	N/A	2012-08-31		426474	6259351	9	GPS unit
Moss	*Sarmentypnum pseudosarmentosum*		S3	Blue-listed	No	No	N/A	N/A	2012-08-31		426191	6259908	9	GPS unit
Lichen	*Cetraria nigricans*		S3	Blue-listed	No	No	N/A	N/A	2012-09-01		426463	6259667	9	GPS unit
Moss	*Sarmentypnum pseudosarmentosum*		S3	Blue-listed	Yes	No	N/A	N/A	2012-09-01		425919	6259997	9	GPS unit
Lichen	*Solorina octospora*		S3	Blue-listed	Yes	No	N/A	N/A	2012-09-01		425175	6260398	9	GPS unit
Lichen	*Solorina octospora*		S3	Blue-listed	Yes	Yes	*Björk 28991*	UBC	2012-09-01		426355	6259982	9	GPS unit
Lichen	*Umbilicaria lambii*		S3	Blue-listed	Yes	Yes	*Björk 28943, 28945, 28965*	UBC	2012-09-01		425877	6260078	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	No	No	N/A	N/A	2012-09-02		426584	6260135	9	GPS unit
Lichen	*Umbilicaria lambii*		S3	Blue-listed	Yes	Yes	*Björk 29037*	UBC	2012-09-02		426791	6259442	9	GPS unit
Lichen	*Placynthium asperellum*		S3?	Blue-listed	No	No	N/A	N/A	2012-07-14		423732	6263275	9	GPS unit
Lichen	*Placynthium asperellum*		S3?	Blue-listed	No	No	N/A	N/A	2012-07-16		448142	6249979	9	GPS unit
Moss	*Helodium paludosum*	Unranked, but rare in BC			Yes	Yes	*Björk 27906*	UBC	2012-07-13		452837	6262561	9	GPS unit
Lichen	*Steineropsis alaskana*	Not listed, Newly discovered for BC, globally rare			No	No	N/A	N/A	2013-08-15		434908	6225004	9	GPS unit
Vascular plant	*Botrychium crenulatum*		S2S3	Blue-listed	No	Yes	*Batten 858*	UBC	2013-08-15		435160	6224560	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	Yes	*Batten 859*	UBC	2013-08-15		434935	6224898	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-15		434846	6225223	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Moss	*Sphagnum aongstroemii*	Moist ground, shallow hollow in alpine heath	2 large patches, thousands of ramets	3 x 3 m	8	Map as point with an 8 m radial buffer	
Lichen	*Bryoria nitidula*	Over moss and gravel on windblown alpine ridgetops	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia subfurcata*	Over moss in rocky tundra	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Solorina bispora*	On ledges of seepy cliffs, alpine	1 large patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Sphaerophorus fragilis*	On friable rock of pinnacles, windblown alpine ridge	Ca. 50 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia pseudalcicornis*	Moist, mossy ground among boulders near small creek, alpine	1 large patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii ssp. behringianum*	Moist, mossy ground among boulders near small creek, alpine	Ca. 10 plants	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Vestergrenopsis elaeina*	Directly attached to rock face of dry or slightly seepy cliff, alpine	Ca. 10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium leptocarpum*	Sloped fen with stunted conifers, upper montane	Ca. 70-80 genets	ca. 20 x 20 m	30	Map as point with a 30 m buffer, trimming away any portion falling outside the treeless portion of the wetland	
Vascular plant	*Carex rostrata x utriculata*	Marshes and pond shores, valley elevation	50,000-100,000 ramets	See Appendix E-3		See Appendix E-3, map of polygon marking (observed portion of) population	ranking for C. rostrata
Vascular plant	*Carex rostrata x utriculata*	In small ponds, partly where disturbed by road, partly where natural	5000-10000 ramets	<50 x 50 m	50	Map as point with a 50 m radial buffer	ranking for C. rostrata
Lichen	*Dermatocarpon leptophyllodes*	Cliff face, where slightly seepy, valley elevations	1 small patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Dermatocarpon leptophyllodes*	On cliff face, slightly seepy, valley elevation	1 patch observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia singularis*	Gravel/cobble bars along river at valley elevation	200-300 patches, each patch of many stems	Unknown		Population bounds not determined	
Moss	*Tomentypnum falcifolium*	In marsh, lower elevation, mineral rich	Unknown	Exact area unknown	10	Map as point with a 10 m radial buffer	
Lichen	*Cladonia singularis*	Over moss on open gravel bars of river	Unknown, probably at least 100 patches	Unknown	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	On moss over gravel, stable scree in lower alpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia singularis*	On moss over gravel, stable scree in lower alpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria delisei*	On ground in rocky alpine tundra, with Racomitrium lanuginosum	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	On ground in rocky alpine tundra, with Racomitrium lanuginosum	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria delisei*	On ground in rocky alpine tundra, with Racomitrium lanuginosum	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	On ground in rocky alpine tundra, with Racomitrium lanuginosum	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	On ground in rocky alpine tundra, with Racomitrium lanuginosum	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Allantoparmelia almquistii*	Saxicolous on rock faces, on windblown alpine ridgetops	1 composite patch, probably all one genet	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	Over moss on rocky tundra, windblown alpine ridge	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Sarmentypnum pseudosarmentosum*	Floating in shallow water of alpine pool in rocky tundra	5-10 clumps, possibly all one genet repeatedly divided	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	Over moss in rocky tundra	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Sarmentypnum pseudosarmentosum*	Submerged in shallow pool in alpine tundra	1 clump observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Solorina octospora*	On ledges of seepy cliffs, alpine	2 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Solorina octospora*	On ledges of seepy cliffs, alpine	1 thallus	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Umbilicaria lambii*	Saxicolous, rock pinnacles, windblown alpine ridge	50-100 thalli	3 x 3 m	10	Map as point with a 10 m radial buffer	
Lichen	*Cladonia singularis*	On mosses on gritty soil on cliff top, alpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Umbilicaria lambii*	On friable rock of pinnacle, alpine	Ca. 20 patches, each patch is probably a single genet	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Placynthium asperellum*	Seepy cliff face, valley elevation	ca. 10 patches	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Placynthium asperellum*	On rock faces where periodically wet	1 composite patch	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Helodium paludosum*	In marsh, lower elevation, mineral rich	Unknown	Exact area unknown	10	Map as point with a 10 m radial buffer	
Lichen	*Steineropsis alaskana*	On rocks in the bottom of a narrow alpine stream	3 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Botrychium crenulatum*	Raised berm along historic creek bank, alpine	ca. 5 plants	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Along creek edge, alpine	10-15 tufts	1 x 5 m	10	Map as point with a 10 m radial buffer	
Vascular plant	*Carex enanderi*	Margin of small alpine tarn	5 tufts	2 x 2 m	5	Map as point with a 5 m radial buffer	

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-15		434942	6224698	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	Yes	*Batten 860*	UBC	2013-08-15		435343	6224438	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	No	No	N/A	N/A	2013-08-15		434761	6225232	9	GPS unit
Liverwort	*Sauteria alpina*	Not listed, rare			Yes	No	N/A	N/A	2013-08-16		436056	6226145	9	GPS unit
Lichen	*Baeomyces carneus*		S1	Red-listed	No	Yes	*Batten 585*	UBC	2013-08-16		435088	6225492	9	GPS unit
Lichen	*Stereocaulon depressum*		S1	Red-listed	No	Yes	*Batten 802*	UBC	2013-08-16		435993	6226930	9	GPS unit
Vascular plant	*Carex praeceptorum*		S1S3	Red-listed	No	Yes	*Batten 862*	UBC	2013-08-16		435993	6226930	9	GPS unit
Lichen	*Stereocaulon arenarium*		S2	Red-listed	No	Yes	*Batten 604*	UBC	2013-08-16		435595	6225163	9	GPS unit
Vascular plant	*Botrychium crenulatum*		S2S3	Blue-listed	Yes	Yes	*Batten 861*	UBC	2013-08-16		435235	6225420	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435265	6225564	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	Yes	No	N/A	N/A	2013-08-16		436020	6226221	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-16		434976	6225467	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435176	6225417	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435829	6225543	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435980	6226608	9	GPS unit
Lichen	*Stereocaulon glareosum*		S2S3	Blue-listed	No	Yes	*Batten 614*	UBC	2013-08-16		435993	6226930	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435485	6227317	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435490	6225278	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435721	6225361	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435972	6227081	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-16		435485	6227317	9	GPS unit
Lichen	*Umbilicaria lambii*		S3	Blue-listed	No	No	N/A	N/A	2013-08-16		434814	6225525	9	GPS unit
Lichen	*Baeomyces carneus*		S1	Red-listed	No	Yes	*Batten 451*	UBC	2013-08-17		433809	6230892	9	GPS unit
Lichen	*Stereocaulon depressum*		S1	Red-listed	No	No	N/A	N/A	2013-08-17		433808	6230899	9	GPS unit
Lichen	*Baeomyces carneus*		S1	Red-listed	No	Yes	*Batten 705*	UBC	2013-08-17		435906	6218744	9	GPS unit
Moss	*Bryum calobryoides*		S1S2	Red-listed	No	Yes	*Batten 778*	UBC	2013-08-17		433798	6230872	9	GPS unit
Vascular plant	*Carex praeceptorum*		S1S3	Red-listed	No	Yes	*Batten 863*	UBC	2013-08-17		433785	6230797	9	GPS unit
Lichen	*Stereocaulon arenarium*		S2	Red-listed	No	No	N/A	N/A	2013-08-17		433808	6230899	9	GPS unit
Lichen	*Stereocaulon botryosum*		S2	Red-listed	No	Yes	*Batten 608*	UBC	2013-08-17		433808	6230899	9	GPS unit
Lichen	*Solorina spongiosa*		S2	Red-listed	No	Yes	*Batten 461*	UBC	2013-08-17		435738	6218839	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-17		433809	6230892	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-17		436103	6218473	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	No	Yes	*Batten 781*	UBC	2013-08-17		433785	6230797	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-17		433825	6230948	9	GPS unit
Vascular plant	*Epilobium x treleasianum*		S3	Blue-listed	No	Yes	*Batten 864*	UBC	2013-08-17		435738	6218839	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-17		436040	6218108	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-17		436042	6218434	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-17		435997	6218568	9	GPS unit
Lichen	*Steineropsis alaskana*	Not listed, Newly discovered for BC, globally rare			No	Yes	*Batten 762*	UBC	2013-08-18		434374	6228798	9	GPS unit
Lichen	*Stereocaulon depressum*		S1	Red-listed	No	No	N/A	N/A	2013-08-18		434870	6229547	9	GPS unit
Vascular plant	*Carex praeceptorum*		S1S3	Red-listed	No	Yes	*Batten 865*	UBC	2013-08-18		434366	6228796	9	GPS unit
Lichen	*Stereocaulon botryosum*		S2	Red-listed	No	Yes	*Batten 462*	UBC	2013-08-18		435049	6228888	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-18		434920	6229567	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-18		435066	6229208	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-18		434366	6228796	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Vascular plant	*Carex enanderi*	Margin of small alpine tarn	10-15 tufts	2 x 2 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Alpine gravel flat	6 plants	2 x 2 m	10	Map as point with a 10 m radial buffer	
Lichen	*Cladonia singularis*	Over rocky outcrop, alpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Liverwort	*Sauteria alpina*	In fine gravel, sheltered by boulders, alpine	3 patches	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Baeomyces carneus*	Terricolous, at margin of low eroding bank, alpine	1 thallus observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon depressum*	Saxicolous, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex praeceptorum*	Margin of small pond on top of rocky promontory, alpine	5-10 tufts	2 x 2 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon arenarium*	Saxicolous, alpine	5-10 thalli	1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Botrychium crenulatum*	Scree hillside with small patches of stabilized soil below Artemisia norvegica plants, alpine	2 plants	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Margin of small alpine tarn	5-10 rammets	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Along creek edge, alpine	ca. 25 tufts	10 x 10 m	10	Map as point with a 10 m radial buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Sparsely vegetated scree slopes, alpine	5-10 plants	2 x 2 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Sparsely vegetated scree slopes, alpine	15-20 plants	2 x 2 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Fine gravel flats below glacier, alpine	20-30 plants	5 x 5 m	10	Map as point with 10 m buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Gravel hillside, alpine	ca. 100 plants	10 x 10 m	20	Map as point with 20 m buffer	
Lichen	*Stereocaulon glareosum*	Saxicolous, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Vestergrenopsis elaeina*	Saxicolous on low, near vertical cliff, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Boulder talus, alpine	5-10 fronds	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Boulder talus, alpine	20-50 fronds	5 x 5 m	10	Map as point with 10 m buffer	
Vascular plant	*Gymnocarpium jessoense*	Scree slopes, alpine	100-200 fronds	10 x 10 m	20	Map as point with 20 m buffer	
Vascular plant	*Gymnocarpium jessoense*	Scree slopes, alpine	15-20 fronds	1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Umbilicaria lambii*	Saxicolous, alpine	20-30 thalli	2 x2 m	5	Map as point with a 5 m radial buffer	
Lichen	*Baeomyces carneus*	Terricolous, at margin of low eroding bank over tarn, alpine	1 thallus observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon depressum*	Saxicolous, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Baeomyces carneus*	Terricolous, at margin of old road cut, subalpine	1 thallus observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Moss	*Bryum calobryoides*	Among other mosses on cliff ledge, alpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex praeceptorum*	Pond margin atop a rocky promontory, subalpine	5-10 tufts	5 x 5 m	10	Map as point with 10 m buffer	
Lichen	*Stereocaulon arenarium*	Saxicolous, alpine	5-10 thalli	1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon botryosum*	Saxicolous, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Solorina spongiosa*	Terricolous over gravel along stabilized road edge	1 thallus	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Vestergrenopsis elaeina*	Saxicolous, alpine	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Margin of small subalpine tarn	10-15 tufts	5 x 5 m	10	Map as point with 10 m buffer	
Lichen	*Cladonia singularis*	Muscicolous/Terricolus in thin soils over rock, subalpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Among boulder talus, subalpine	150-200 fronds	10 x 10 m	20	Map as point with 20 m buffer	
Vascular plant	*Epilobium x treleasianum*	Along gravel road edge with other epilobium species, low subalpine	5-10 plants	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Along gravel road edge extending into the forest edge, low subalpine	250-500 fronds	10 x 10 m	10	Map as point with 10 m buffer	
Vascular plant	*Gymnocarpium jessoense*	Along gravel road edge extending into the forest edge, low subalpine	50-100 fronds	5 x 5 m	10	Map as point with 10 m buffer	
Vascular plant	*Gymnocarpium jessoense*	Along gravel road edge extending into the forest edge, low subalpine	50-100 fronds	5 x 5 m	10	Map as point with 10 m buffer	
Lichen	*Steineropsis alaskana*	On rocks in the bottom of a narrow sub/alpine stream	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon depressum*	Saxicolous on windswept rock bald, subalpine	ca. 5 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex praeceptorum*	Margin of small subalpine tarn on rocky promontory	5-10 tufts	2 x 2 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon botryosum*	Saxicolous on vertical face of large boulders, subalpine	2 thalli observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Margin of small subalpine tarn	20-30 tufts	5 x 5 m	10	Map as point with 10 m buffer	
Vascular plant	*Carex enanderi*	Margin of small creek, subalpine	2 tufts	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Vestergrenopsis elaeina*	Saxicolous on low vertical cliff, subalpine	10-15 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Lichen	*Cladonia singularis*		S3	Blue-listed	No	Yes	*Batten 726*	UBC	2013-08-18		434366	6228796	9	GPS unit
Lichen	*Cladonia coccifera*		S1	Red-listed	No	Yes	N/A	N/A	2013-08-19		434876	6228528	9	GPS unit
Lichen	*Hydrothyria venosa* s. lat.		S1S2	Red-listed	Yes	Yes	*Batten 466*	UBC	2013-08-19		434933	6228225	9	GPS unit
Vascular plant	*Ranunculus occidentalis* var. *hexasepalus*		S1S3	Red-listed	No	Yes	*Batten 866*	UBC	2013-08-19		435475	6228404	9	GPS unit
Lichen	*Cladonia macrophylla*		S2	Red-listed	No	Yes	N/A	N/A	2013-08-19		434876	6228528	9	GPS unit
Lichen	*Stereocaulon botryosum*		S2	Red-listed	No	Yes	*Batten 628*	UBC	2013-08-19		434875	6228187	9	GPS unit
Vascular plant	*Botrychium crenulatum*		S2S3	Blue-listed	Yes	No	N/A	N/A	2013-08-19		435508	6228447	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		434933	6228225	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		434951	6228118	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		435213	6228206	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		435305	6228220	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		435059	6228713	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	No	Yes	N/A	N/A	2013-08-19		435092	6228173	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		435477	6228424	9	GPS unit
Lichen	*Stereocaulon glareosum*		S2S3	Blue-listed	No	Yes	*Batten 731*	UBC	2013-08-19		435529	6228818	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-19		434885	6228300	9	GPS unit
Lichen	*Cladonia singularis*		S3	Blue-listed	No	Yes	N/A	N/A	2013-08-19		435447	6228325	9	GPS unit
Lichen	*Collema ceraniscum*		S1	Red-listed	No	Yes	*Batten 735*	UBC	2013-08-20		433572	6232330	9	GPS unit
Lichen	*Hydrothyria venosa* s. lat.		S1S2	Red-listed	Yes	Yes	*Batten 816*	UBC	2013-08-20		433575	6232501	9	GPS unit
Lichen	*Hydrothyria venosa* s. lat.		S1S2	Red-listed	Yes	Yes	*Batten 816*	UBC	2013-08-20		434198	6231019	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-20		434270	6230923	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-08-20		433575	6232501	9	GPS unit
Lichen	*Stereocaulon glareosum*		S2S3	Blue-listed	No	Yes	*Batten 627*	UBC	2013-08-20		434720	6230419	9	GPS unit
Vascular plant	*Woodsia alpina*		S2S3	Blue-listed	No	Yes	*Batten 867*	UBC	2013-08-20		434860	6230491	9	GPS unit
Moss	*Amblyodon dealbatus*		S3	Blue-listed	No	Yes	*Batten 524*	UBC	2013-08-20		434687	6230359	9	GPS unit
Lichen	*Cetraria nigricans*		S3	Blue-listed	No	Yes	*Batten 443*	UBC	2013-08-20		434720	6230419	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-20		433575	6232501	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-20		433572	6232330	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-20		434305	6230863	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-08-20		434204	6231021	9	GPS unit
Vascular plant	*Micranthes nelsoniana* var. *carlottae*		S3	Blue-listed	No	No	N/A	N/A	2013-08-20		433572	6232330	9	GPS unit
Vascular plant	*Botrychium spathulatum*		S1	Red-listed	Yes	Yes	*Björk 32498*	UBC	2013-07-11	Site 2	43355	622986	9	GPS unit
Lichen	*Solorina spongiosa*		S2	Red-listed	Yes	No	N/A	N/A	2013-07-11	Site 2	433552	6229860	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-11	Site 2	433552	6229860	9	GPS unit
Moss	*Dicranum montanum*		S3	Blue-listed	No	Yes	*Björk 31807*	UBC	2013-07-11	Site 2	433495	6230424	9	GPS unit
Lichen	*Steineropsis alaskana*	Not listed, Newly discovered for BC, globally rare			No	No	N/A	N/A	2013-07-13	Site 1	434735	6223851	9	GPS unit
Lichen	*Cladonia subfurcata*		S2S3	Blue-listed	No	Yes	*Björk 31870*	UBC	2013-07-13	Site 1	434735	6223851	9	GPS unit
Lichen	*Stereocaulon capitellatum*		S1	Red-listed	Yes	Yes	*Björk 31814*	UBC	2013-07-13	Site 2	434365	6228793	9	GPS unit
Lichen	*Stereocaulon symphycheilum*		S1S2	Red-listed	No	No	N/A	N/A	2013-07-14	Site 1	434826	6225079	9	GPS unit
Lichen	*Solorina octospora*		S3	Blue-listed	No	Yes	*Björk 31928*	UBC	2013-07-14	Site 1	434826	6225079	9	GPS unit
Lichen	*Stereocaulon glareosum*		S2S3	Blue-listed	Yes	Yes	*Björk 31771*	UBC	2013-07-11	Site 1	433551	6244357	9	GPS unit
Moss	*Pohlia* sp. nov.	Not listed, a rare new species			Yes	Yes	*Björk 31772*	UBC	2013-07-11	Site 1	433551	6244357	9	GPS unit
Moss	*Pohlia* sp. nov.	Not listed, a rare new species			Yes	Yes	*Björk 31772*	UBC	2013-07-11	Site 1	433668	6243605	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Lichen	*Cladonia singularis*	Muscicolous/Terricolus in thin soils over rock, subalpine	ca. 5 small semi-continuous patches	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia coccifera*	Muscicolous/Terricolus with other species of cladonia, subalpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Hydrothyria venosa* s. lat.	Over rocks in the bottom a small flowing stream	2 large patches, fertile	5 x 5 m	10	Map as point with a 10 m radial buffer	
Vascular plant	*Ranunculus occidentalis* var. *hexasepalus*	On raised banks at the base of old avalanche track, subalpine	30-50 plants	10 x 10 m	20	Map as point with a 20 m radial buffer	
Lichen	*Cladonia macrophylla*	Muscicolous/Terricolus with other species of cladonia, subalpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon botryosum*	Saxicolous on rock bald of small promontory	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Botrychium crenulatum*	Along raised banks of steep, dry creek with Artemisia norvegica, Gentiana platypetala and other Botrychiums	1 plant observed	<1 x 1 m	10	Map as point with a 10 m radial buffer	
Vascular plant	*Carex enanderi*	Margin of narrow subalpine stream	10-15 tufts	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Along edge of subalpine tarn	5-10 tufts	1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Along edge and extending into shallow margins of subalpine tarn	30-50 tufts	10 x 10 m	10	Map as point with a 10 m radial buffer	
Vascular plant	*Carex enanderi*	Along edge and extending into shallow margins of subalpine tarn	ca. 20 tufts	5 x 5 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Wet subalpine depression of a no longer flowing stream	25-50 tufts	1 x 10 m	10	Map as point with a 10 m radial buffer	
Lichen	*Cladonia pseudalcicornis*	Muscicolous above and in water's edge along small stream	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Over coarse gravel flats at the base of old avalanche track, subalpine	20-50 plants	5 x 5 m	10	Map as point with a 10 m radial buffer	
Lichen	*Stereocaulon glareosum*	On gravel flat among mosses	5-10 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Vestergrenopsis elaeina*	Saxicolous on low, near vertical cliff, alpine	2 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cladonia singularis*	Muscicolous/Terricolus in thin soils over rock, subalpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Collema ceraniscum*	Saxicolous over base rich rock with Euopsis pulvinata	4 thalli	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Hydrothyria venosa* s. lat.	Over rocks in the bottom a small flowing stream	small patch, fertile	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Hydrothyria venosa* s. lat.	Over large boulders in the bottom a small flowing stream, above and below 2 m. cascade	several large patches, fertile	2 x 2	10	Map as point with a 10 m radial buffer	
Lichen	*Cladonia pseudalcicornis*	Muscicolous above and in water's edge along small stream	2 large patches	1 x 2 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Carex enanderi*	Along margin of small stream, subalpine	15-20 tufts	2 x 2 m	5	Map as point with a 5 m radial buffer	
Lichen	*Stereocaulon glareosum*	Over fine soil and gravel, alpine	2 thalli observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Woodsia alpina*	At the base of large (ca. 20 m cliff)	5-10 plants	10 x 10 m	40	Map as point with a 40 m radial buffer, (note GPS had high inaccuracy +/- 25 m from cliff)	
Moss	*Amblyodon dealbatus*	Between low rock bank and stream edge, some calcareous influence, subalpine	Unknown	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Lichen	*Cetraria nigricans*	Muscicolous/Saxicolous, subalpine	2 thalli observed	<1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Around boulder bases at stream edge, subalpine	10-25 fronds	2 x 2 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Boulder talus slope, subalpine	200-250 fronds		10	Map as point with a 10 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Scree slopes trailing into Abies and Tsuga forest, subalpine	750-1000 fronds	10 x 10 m	20	Map as point with a 20 m radial buffer	
Vascular plant	*Gymnocarpium jessoense*	Stabilized bank next to small cascade, subalpine	ca. 20 fronds	1 x 1 m	5	Map as point with a 5 m radial buffer	
Vascular plant	*Micranthes nelsoniana* var. *carlottae*	Gravel runnels above stream bank, subalpine	20-50 plants	2 x 2	10	Map as point with a 10 m radial buffer	
Vascular plant	*Botrychium spathulatum*	At base of cliff, gravelly soil, near road margin, lower subalpine	4 genets	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Solorina spongiosa*	On thin soil of cliff base, lower subalpine	1 patch	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Vestergrenopsis elaeina*	Cliff faces near creek, lower subalpine	7 thalli	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Moss	*Dicranum montanum*	On cliff ledge, lower subalpine	1 patch observed	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Steineropsis alaskana*	On rock in periodic stream, lower subalpine	1 thallus	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Cladonia subfurcata*	In heaths, lower subalpine	2 patches observed	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Stereocaulon capitellatum*	On cliff ledge, lower subalpine	1 patch of ca. 50 thalli	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Stereocaulon symphycheilum*	On cliff ledge, lower subalpine	1 patch observed	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Solorina octospora*	Cliff base, sheltered by overhang, lower subalpine	1 patch	1 x 1 m	4	Map as point with a 4 m radial buffer	(Garmin eTrex Venture)
Lichen	*Stereocaulon glareosum*	On sand in glacier foreland, montane, growing with Cryptogramma acrostichoides	Ca. 100 patches	20 x 20 m	25	Map as point with a 25 m radial buffer	(Garmin eTrex Venture)
Moss	*Pohlia* sp. nov.	Sandy soil, seepage at base of gossen rock outcrop, montane, in glacier foreland, growing with Ptychostomum schleicheri	1 large composite patch (probably multiple genets)	3 x 3 m	7	Map as point with a 7 m radial buffer	(Garmin eTrex Venture)
Moss	*Pohlia* sp. nov.	Sandy soil, seepage at base of gossen rock outcrop, montane, in glacier foreland, growing with Ptychostomum schleicheri	1 large composite patch (probably multiple genets)	3 x 3 m	7	Map as point with a 7 m radial buffer	(Garmin eTrex Venture)

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Moss	*Ptychostomum schleicheri*		S2S3	Blue-listed	Yes	Yes	*Björk 31826*	UBC	2013-07-11	Site 1	433551	6244357	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-13	Site 7	434745	6225782	9	GPS unit
Vascular plant	*Polypodium* cf. *interjectum*	Not listed, a possbile taxonomic novelty, rare			Yes	Yes	*Björk 32488*	UBC	2013-07-10	Site 1	434689	6246686	9	GPS unit
Vascular plant	*Polypodium* cf. *interjectum*	Not listed, a possbile taxonomic novelty, rare			Yes	Yes	*Björk 32488*	UBC	2013-07-10	Site 1	434884	6246924	9	GPS unit
Vascular plant	*Polypodium* cf. *interjectum*	Not listed, a possbile taxonomic novelty, rare			Yes	Yes	*Björk 32488*	UBC	2013-07-10	Site 1	434630	6246947	9	GPS unit
Lichen	*Cladonia coccifera*		S1	Red-listed	Yes	Yes	*Björk 31765*	UBC	2013-07-10	Site 1	434908	6246955	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	Yes	No	N/A	N/A	2013-07-10	Site 1	434703	6246682	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-10	Site 1	434677	6246662	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-10	Site 1	434695	6246664	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-10	Site 1	434756	6246717	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-10	Site 1	434760	6246716	9	GPS unit
Vascular plant	*Polypodium* cf. *interjectum*	Not listed, a possbile taxonomic novelty, rare			Yes	Yes	*Björk 32496*	UBC	2013-07-10	Site 2	434723	6247289	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Moss	*Ptychostomum schleicheri*	Sandy soil, seepage at base of gossen rock outcrop, montane, in glacier foreland, growing with Pohlia sp. nov.	1 large composite patch (probably multiple genets)	3 x 3 m	7	Map as point with a 7 m radial buffer	(Garmin eTrex Venture)
Lichen	*Cladonia pseudalcicornis*	Around pool, lower subalpine, growing with Arnica latifolia, Arnica griscomii, Luetkea,Luzula parviflora, Cassiope mertensiana	Ca. 5000 thalli	7 x 5 m	10	Map as point with a 10 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Polypodium* cf. *interjectum*	Crevices and underhangs of argillite cliffs, rock promontories in forest clearings, montane	200-500 genets (patches)	three subpopulations, each of about 25 x 25 m or somewhat more, the very steep, rocky terraine makes it difficult to assess this	50	Map as three points (use coordinates given), each with a 50 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Polypodium* cf. *interjectum*	Crevices and underhangs of argillite cliffs, rock promontories in forest clearings, montane	200-500 genets (patches)	three subpopulations, each of about 25 x 25 m or somewhat more, the very steep, rocky terraine makes it difficult to assess this	50	Map as three points (use coordinates given), each with a 50 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Polypodium* cf. *interjectum*	Crevices and underhangs of argillite cliffs, rock promontories in forest clearings, montane	200-500 genets (patches)	three subpopulations, each of about 25 x 25 m or somewhat more, the very steep, rocky terraine makes it difficult to assess this	50	Map as three points (use coordinates given), each with a 50 m radial buffer	(Garmin eTrex Venture)
Lichen	*Cladonia coccifera*	Crevices and ledges of argillite cliffs, rock promontories in forest clearings, montane	Ca. 2000 podetia	30 x 30 m	50	Map as point with a 50 m radial buffer	(Garmin eTrex Venture)
Lichen	*Vestergrenopsis elaeina*	On cliff faces on rock promontories, in forest clearings, montane, with Bucklandiella, Onchophorus, Rhizocarpon spp., Vestergrenopsis isidiata	Ca. 100 thalli	5 x 5 m	5	Map as point with a 5 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Among boulders in talus, below cliffs of argillite, forest clearings, montane, with Bucklandiella, Niphotrichum, Onchophorus	7 patches, ca. 100 ramets	Unknown, terraine too difficult to traverse	100	Map as point with a 100 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Among boulders in talus, below cliffs of argillite, forest clearings, montane, with Bucklandiella, Niphotrichum, Onchophorus	7 patches, ca. 100 ramets	Unknown, terraine too difficult to traverse	100	Map as point with a 100 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Among boulders in talus, below cliffs of argillite, forest clearings, montane, with Bucklandiella, Niphotrichum, Onchophorus	7 patches, ca. 100 ramets	Unknown, terraine too difficult to traverse	100	Map as point with a 100 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Among boulders in talus, below cliffs of argillite, forest clearings, montane, with Bucklandiella, Niphotrichum, Onchophorus	7 patches, ca. 100 ramets	Unknown, terraine too difficult to traverse	100	Map as point with a 100 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Polypodium* cf. *interjectum*	On cobble bars along river in glacier foreland, growing with Dryas drumm., Cryptogramma, Epilobium latifolium, Niphotrichum, Orthilia secunda	Ca. 150 genets (patches)	Ca. 200 x 100 m		Map as ellipse oriented with its long (200 m) axis E-W	(Garmin eTrex Venture)

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Rank Status	S_Rank	CDC_List	Field Photo	Specimen	Specimen ID	Herbarium	Date_Obs	Site	UTM East	UTM North	UTM Zone	UTM Source
Vascular plant	*Polypodium* cf. *interjectum*	Not listed, a possbile taxonomic novelty, rare			Yes	Yes	*Björk 32496*	UBC	2013-07-10	Site 2	434688	6247220	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	Yes	No	N/A	N/A	2013-07-11	Site 2	433828	6230767	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	Yes	No	N/A	N/A	2013-07-11	Site 2	433830	6231364	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	Yes	No	N/A	N/A	2013-07-11	Site 2	433495	6230424	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	Yes	*Björk 31855*	UBC	2013-07-13	Site 1	434735	6223851	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-13	Site 1	434735	6223851	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-13	Site 4	435277	6227247	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-13	Site 4	435277	6227247	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-13	Site 6	434868	6226740	9	GPS unit
Moss	*Andreaea sinuosa*		S2	Red-listed	Yes	Yes	*Bj örk 31914*	UBC	2013-07-13	Site 7	434745	6225782	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	Yes	No	N/A	N/A	2013-07-13	Site 7	434745	6225782	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-13	Site 7	434703	6225843	9	GPS unit
Lichen	*Steineropsis alaskana*	Not listed, Newly discovered for BC, globally rare			No	No	N/A	N/A	2013-07-14	Site 1	434927	6224973	9	GPS unit
Lichen	*Vestergrenopsis elaeina*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-14	Site 1	434784	6225369	9	GPS unit
Vascular plant	*Carex enanderi*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-14	Site 1	434831	6225245	9	GPS unit
Lichen	*Cladonia pseudalcicornis*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-14	Site 1	434836	6225231	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-14	Site 1	434741	6225405	9	GPS unit
Vascular plant	*Gymnocarpium jessoense*		S3	Blue-listed	No	No	N/A	N/A	2013-07-14	Site 2	434695	6221165	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	Yes	No	N/A	N/A	2013-07-14	Site 4	435451	6218228	9	GPS unit
Vascular plant	*Draba glabella*		S2S3	Blue-listed	Yes	No	N/A	N/A	2013-07-14	Site 4	435518	6218281	9	GPS unit
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*		S2S3	Blue-listed	No	No	N/A	N/A	2013-07-14	Site 4	435345	6218121	9	GPS unit

Appendix 8-4. Locations of the Rare Plants and Lichens Observed in the 2012 - 2013 Surveys

Lifeform	Taxon	Habitat	Popn_Size	Popn_Area	Map_Buffer	For_Map	Comment
Vascular plant	*Polypodium* cf. *interjectum*	On cobble bars along river in glacier foreland, growing with Dryas drumm., Cryptogramma, Epilobium latifolium, Niphotrichum, Orthilia secunda	Ca. 150 genets (patches)	Ca. 200 x 100 m		Map as ellipse oriented with its long (200 m) axis E-W	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	On thin soil of cliff base, lower subalpine	500-1000 ramets	50 x 50 m	50	Map as point with a 50 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	On thin soil of cliff base, lower subalpine	500-1000 ramets	50 x 50 m	50	Map as point with a 50 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	On thin soil of cliff base, lower subalpine	500-1000 ramets	50 x 50 m	50	Map as point with a 50 m radial buffer	(Garmin eTrex Venture)
Lichen	*Vestergrenopsis elaeina*	On rock along stream, and on cliff face, lower subalpine	Ca. 10 thalli observed	1 x 1 m	5	Map as point with a 5 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Cliff base and talus, lower subalpine, growing with Cassiope mert, Luetkea, Harrimanella, Vacc memb	Ca. 1500 ramets	100 x 100 m	100	Map as point with a 100 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	On gritty soil at creek margin, lower subalpine	100-200 genets	10 x 10 m	15	Map as point with a 15 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Cliff base and road side, lower subalpine	50-100 ramets	30 x 5 m		Map as ellipse oriented with its long (30 m) axis oriented N-S	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Various rocky sites, lower subalpine	1000-2000 ramets	50 x 50 m	50	Map as point with a 50 m radial buffer	(Garmin eTrex Venture)
Moss	*Andreaea sinuosa*	On rock in talus, lower subalpine, with lichinoid cyanolichens (Cryptothele, Pyrenopsis)	2 patches observed	1 x 1 m	5	Map as point with a 5 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Carex enanderi*	Around pool, lower subalpine	500-1000 genets	10 x 10 m	15	Map as point with a 15 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Various rocky sites, lower subalpine	100-200 genets	Unknown, not recorded	10	Map as point with a 10 m radial buffer	(Garmin eTrex Venture)
Lichen	*Steineropsis alaskana*	On stones along stream, lower subalpine	50-100 thalli	Ca. 20 m stretch of a stream	25	Map as a point with a 25 m radial buffer	(Garmin eTrex Venture)
Lichen	*Vestergrenopsis elaeina*	Cliff face, lower subalpine	Ca. 20 thalli	5 x 5 m	10	Map as point with a 10 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Carex enanderi*	Along pool margins in heaths, lower subalpine, with Leptarrhena pyrolifolia, Fauria crista-galli	3 genets	1 x 1 m	5	Map as point with a 5 m radial buffer	(Garmin eTrex Venture)
Lichen	*Cladonia pseudalcicornis*	Seepy site in heath, lower subalpine, growing with Luetkea, Leptarrhena, Cassiope	40 patches	10 x 10 m	15	Map as a point with a 15 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Cliff bases, lower subalpine	1000-5000 ramets	50 x 50 m	50	Map as point with a 50 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Gymnocarpium jessoense*	Cliff bases, lower subalpine, at road margin	100-200 ramets	50 x 50 m	50	Map as a point with a 50 m radial buffer	(Garmin eTrex Venture)
Vascular plant	*Draba glabella*	Cliff bases, lower subalpine, at road margin	9 genets	1 x 200 m		Map as a line paralelling the Salmon Glacier Road, east side (uphill side) of the road	(Garmin eTrex Venture)
Vascular plant	*Draba glabella*	Cliff bases, lower subalpine, at road margin	9 genets	1 x 200 m		Map as a line paralelling the Salmon Glacier Road, east side (uphill side) of the road	(Garmin eTrex Venture)
Vascular plant	*Epilobium hornemannii* ssp. *behringianum*	Cliff bases, lower subalpine, at road margin	Ca. 50 genets	1 x 200 m		Map as a line paralelling the Salmon Glacier Road, east side (uphill side) of the road	(Garmin eTrex Venture)

Appendix 9

2012 Soil, Lichen and Plant Tissue Metals Report

Rescan™
Engineers and Scientists

Pretium Resources Inc.

BRUCEJACK GOLD MINE PROJECT
2012 Soil, Lichen and Plant Tissue Metals Report

PRETIVM

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May 2013

BRUCEJACK GOLD MINE PROJECT

2012 SOIL, LICHEN AND PLANT TISSUE METALS REPORT

May 2013
Project #1042-008-02 & 1042-008-03

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Prepared for:

Pretium Resources Inc.

Prepared by:

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary

Rescan™
Engineers and Scientists

Executive Summary

The Brucejack Gold Mine Project (the Project) is situated within the Sulphurets District in the Iskut River region, approximately 20 kilometres northwest of Bowser Lake or 65 kilometres north-northwest of the town of Stewart, British Columbia. In support of a potential environmental assessment of the Brucejack Gold Mine Project, baseline studies were carried out in 2012. Field surveys for terrain, soils, ecosystems and vegetation were carried out along the Exploration Access Road (and proposed Brucejack Transmission Line - East Option), along the proposed Brucejack Transmission Line - South Option, and in the Brucejack Mine Site area.

As part of the terrestrial ecosystem baseline studies, soil, lichen, berry and plant tissue samples were collected and analyzed to characterize baseline metal concentrations. This data comprises a preliminary basis on which to evaluate any changes in metal concentration in receptor materials levels during the life of the Project. These samples were collected and analyzed as part of terrestrial baseline studies, though these results may be used for assessing soil suitability for use in reclamation, country foods assessments and/or future environmental effects monitoring programs.

Soil samples were collected from within the Local Study Area (LSA) and at Reference sites outside of the LSA. A total of 48 soil samples (including three duplicates), from 34 soil sample sites were collected. Corresponding tissue sampling occurred at 23 of these soil sampling sites. Soil samples were analyzed for soil reaction (pH) and a suite of 31 metals, of which 19 have CCME Industrial Use Guideline criteria values. The sampled soils display a wide range of soil reaction (pH 3.8 to 8.1), though are predominantly acidic with approximately 90% of the samples having a pH less than 6.0. Four of the 48 samples, including one duplicate, display values that are within the CCME's suitable pH range (6.0 to 8.0). One sample exceeded the CCME guideline's upper pH limit of 8.0.

Soil metals of potential concern are those whose concentrations exceed the CCME industrial use criteria. Seven of the nineteen CCME metals were found to exceed industrial use criteria at least once. These included the following: antimony (n = 2), arsenic (n = 31), chromium (n = 1), copper (n = 2), nickel (n = 8), thallium (n = 4) and vanadium (n = 2). Arsenic is the most frequently occurring soil metal of concern and its exceedances are distributed throughout the LSA, though its highest concentrations are found in the vicinity of the Mine Site. Exceedances of arsenic most commonly occur alone although in a few instances they occur paired with other metals (with nickel at one site along the Exploration Access Road and with thallium and or antimony at three sites at the Mine Site). Soil nickel concentration displayed the second most frequent exceedance of criteria. At sampling sites with both near surface and sub-surface samples, sample exceedances commonly occurred at both sample depths (10 of 11 sampling sites). The twelve CCME soil metals not exceeding industrial soil use criteria include the following: Ba, Be, Cd, Co, Pb, Hg, Mo, Se, Ag, Sn, U, and Zn.

A total of 83 lichen and plant tissue samples were collected from within the LSA and at Reference sites. These samples were analyzed for a suite of 39 metals. Vegetation samples included 22 lichen samples comprising two species, black footed reindeer lichen (*Cladina stygia*) and eyed foam lichen (*Stereocaulon tomentosum*). Three of these samples from the Mine Site area contained higher concentration of arsenic than rest of the samples. These sampling sites also correspond to sites with elevated arsenic in the soils.

A total of 31 berry samples were collected. Five species were targeted for sampling including oval leaf blueberry (*Vaccinium ovalifolium*), black huckleberry (*Vaccinium membranaceum*), bog blueberry

(*Vaccinium uliginosum*), highbush cranberry (*Vaccinium edule)* and soapberry (*Shepherdia canadensis*). Ten of the 14 metals detected in the berry samples collected from along South Option Transmission Line proposed alignment displayed relatively high concentrations compared with other samples.

Thirty water sedge (*Carex aquatilis*) tissue samples were collected from ten sites around the Exploration Access Road. Some metal species concentrations were routinely low in sedges, often below detection limits.

Overall, metal concentrations in the tissue samples varied depending on the plant species and sampling site. Based on a comparison of the 90th percentile values for the tissue sampled (lichen, berry and sedge), samples of lichen were higher in Al, berry samples were higher in Na, K, P and sedges displayed higher Ca and Zn. Concentrations for other metals were similar across the range of vegetation sample types.

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BRUCEJACK GOLD MINE PROJECT
2012 SOIL, LICHEN AND PLANT TISSUE METALS REPORT

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1. Introduction

1. Introduction

From 2009 to 2012, Rescan Environmental Services was engaged to undertake environmental and socio-economic baseline studies for the proposed Brucejack Gold Mine Project (the Project). The Project is located within the Kitimat-Stikine Regional District of northwest British Columbia, approximately 65 km north-northwest of Stewart, and 21 km south-southeast of the Eskay Creek Mine.

Fugitive dust created by Project-related activities can alter metal concentrations in soils and vegetation. If this occurs, there is potential that metals in soils and vegetation can enter the food chain and affect food quality for wildlife and humans. They can also alter plant vigour and/or community composition. Therefore, as part of the environmental baseline studies, soil, lichen, berry, and plant tissue samples were collected to establish baseline metal concentrations. Analysis of these materials determine baseline metal levels in the area of proposed infrastructure as well as reference sites outside of the expected zone of influence of Project environmental effects. Results from the baseline metals analysis may be will for assessing soil suitability for use in reclamation, country foods assessments and/or future environmental effects monitoring programs.

For the purposes of this study, the LSA was divided into three separate Sub-areas representing zones of similarity with respect to landforms, vegetation types, and expected nature of disturbance. These are presented in Figure 1-1.

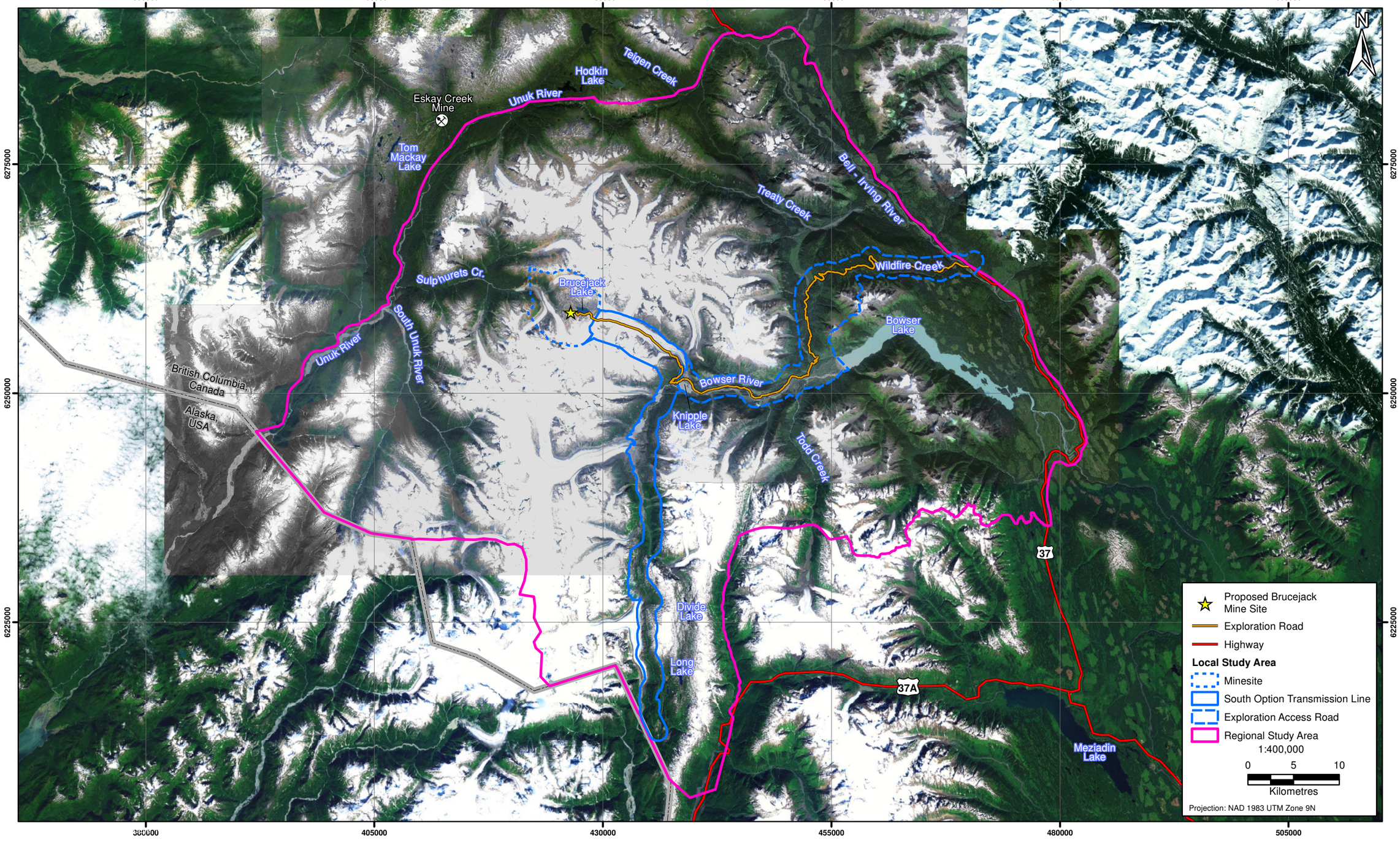

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Figure 1-1

Terrestrial Ecosystems Study Areas

2. Methods

2. Methods

2.1 SOIL SAMPLING AND ANALYSIS

2.1.1 Soil Sample Collection and Analyses

Soil samples were collected as part of the baseline studies designed to inventory and describe the full range of soils, ecosystems and vegetation in the LSA. A total of 49 soil samples were collected from the 34 sites, distributed as shown in Table 2.1-1. This included 37 samples from 10-20 cm soil depth and 11 samples from 50-60 cm soil depth. A single sample was taken at 30-40 cm as bedrock was encountered. Twenty-six of the 34 soil sampling sites were sampled in conjunction with the plant tissue sampling.

Soil samples were placed in clean, plastic, labelled bags and submitted to ALS Environmental (ALS), Burnaby, BC, for laboratory analysis. Samples were analyzed for soil reaction and concentration of 31 metals. Soil parameters measured and the realized detection limits are listed in Table 2.1-2.

Soil pH was determined using dried soil mixed with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution was then measured using a standard pH probe. Metals analysis was carried out using standard procedures from Contaminated Site Regulations (CSR) analytical method, and procedures adapted from EPA Method 200.2.

2.1.2 Soil Data Analysis

Summary statistics (maximum, minimum, median and mean values) were calculated for all soil parameters and summarized by various groupings. The results of these summaries are discussed in Section 3. For statistical calculations values below the detection limit were replaced with values equal to one-half of the detection limit. All soil metal concentrations were compared to Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for the protection of environmental and human health for industrial use (CCME 2012), as listed in Table 2.1-2.

2.2 LICHEN AND PLANT TISSUE SAMPLING AND ANALYSIS

Uptake, allocation and concentration of various metals differ according to factors such as species, tissue type, time of year, soil type, and distance to source of contamination (Bagatto and Shorthouse 1990; Pugh, Dick, and Fredeen 2002; Mbila and Thompson 2004; Poykio et al. 2005). For this reason, metal concentrations in lichens, berries and sedge tissues were summarized separately depending on each species/tissue type. A summary of the type of tissue sampled and its general sampling location (infrastructure or reference area) is provided in Table 2.2-1. Photographs of the various lichens and plant species (shrubs and sedges) sampled as part of this program are provided in Appendix 1.

2.2.1 Tissue Metals Analysis

All sample results presented in Table 2.2-2 are reported on a dry weight basis in the appendices. Dry weight represents an objective measure of metal concentration as it is independent of tissue moisture content, which can vary greatly over time and season. Wet weight results are included to approximate field conditions, as encountered at the time of sampling.

Table 2.1-1. Soil and Tissue Sampling Sites in 2012

Mine Site LSA								
			Soil Depth			Tissue Collected		
Sampling Site	Easting	Northing	20 cm	40 cm	60 cm	Lichens	Berry	Sedge
BJ014	6259142	425991	1		1			
12-1705	6260376	426364	1		1			
BJ015	6258785	426894	1		1	*C. Stygia*		
12-7137	6258807	426423	1		1	*C. Stygia*		
BJ CAMP 4	6259804	428178	1					
BJ CAMP 1	6258065	427964	1			*C. Stygia*		
BJ CAMP 2	6257808	425935	1			*C. Stygia*		
V030	6258785	425201	1			*C. Stygia*		
DUP1	6258807	426423	1		1	*C. Stygia*		
DUP2	6260376	426364	1			*C. Stygia*		
BJ013	6258860	425661	1			*C. Stygia*		
BJ CAMP 3	6260220	425105				*C. Stygia*		
12-7139	6260834	426250				*C. Stygia*		
BJ013-S1	6258860	425661				*C. Stygia*	*V. uliginosum*	
BJ013-S2	6258860	425661					*V. uliginosum*	
Exploration Access Road LSA								
			Soil Depth			Tissue Collected *		
Sampling Site	Easting	Northing	20 cm	40 cm	60 cm	Lichens	Berry	Sedge
12-7169	6249799	445738	1				*V. ovalifolium*, *V. membranaceum*	
12-7166	6260024	452118	1				*V. ovalifolium*	
BJ022	6263540	459334	1		1			
BJ021	6263617	461900						
12-7168	6261576	452690	1		1			
12-7167	6260702	450441	1	1			*V. ovalifolium*	
BJ025	6263576	457297	1		1			
12-7108	6262995	455975	1					
12-7162	6264963	459391	1					
BJ018	6250744	443244	1				*S. canadensis*	
12-7168	6261576	452690	1				*V. ovalifolium*	
SOIL 4	6262865	469503	1				*V. ovalifolium*, *V. membranaceum*	
SOIL 1	6260382	468344	1				*V. membranaceum*, *V. edule*	
SOIL 3	6262278	468826	1				*V. ovalifolium*, *V. membranaceum*	
SOIL 2	6259805	467215	1				*V. ovalifolium*, *V. membranaceum*	
LEACH SITE 3	6259296	468683	1					

(continued)

Table 2.1-1. Soil and Tissue Sampling Sites in 2012 (completed)

Exploration Access Road LSA *(cont'd)*								
			Soil Depth			Tissue Collected *		
Sampling Site	Easting	Northing	20 cm	40 cm	60 cm	Lichens	Berry	Sedge
LEACH SITE 1	6259461	468472	1				*V. ovalifolium*, *V. membranaceum*	
LEACH SITE 2	6259290	468619	1					
BJ024	6263537	457423				*C. Stygia*	*V. ovalifolium*	
BJ019	6250722	444536					*V. ovalifolium*, *V. membranaceum*	
BJ020	6249718	447285					*V. membranaceum*	
SOIL 3-2	6262278	468826					*V. membranaceum*	
BJ031	6251196	438196	1					
W005*	6260624	452059						*C. aquatilis*
W009*	6262682	452931						*C. aquatilis*
W012*	6260673	467665						*C. aquatilis*
W023*	6253678	453833						*C. aquatilis*
W025*	6258420	468828						*C. aquatilis*
W037*	6264375	451453						*C. aquatilis*
W047*	6263193	457119						*C. aquatilis*
W055*	6264618	465858						*C. aquatilis*
W058*	6255470	452356						*C. aquatilis*
W060*	6259907	453137						*C. aquatilis*
South Option Transmission Line LSA								
			Soil Depth			Tissue Collected *		
Sampling Site	Easting	Northing	20 cm	40 cm	60 cm	Lichens	Berry	Sedge
BJ REF EAST 1	6255710	438494	1			*C. Stygia*	*V. uliginosum*	
BJ REF SOUTH	6245378	430298	1			*C. Stygia*		
BJ REF NORTH 2	6276600	424991	1		1	*C. Stygia*		
BJ REF WEST	6256805	417103	1			*C. Stygia*		
BJ REF EAST 2	6254887	441895	1			*C. Stygia*		
BJ REF NORTH 1	6265181	425747	1			*C. Stygia*		
DUP3	6254887	441895	1			*C. Stygia*		
BJ REF SOUTH-S1	6245378	430298					*V. uliginosum*	
BJ REF SOUTH-S2	6245378	430298					*V. uliginosum*	
Reference Locations								
			Soil Depth			Tissue Collected *		
Sampling Site	Easting	Northing	20 cm	40 cm	60 cm	Lichens	Berry	Sedge
BJ030	6250502	437021	1		1	*Ster* sp.	*V. membranaceum*, *S. canadensis*	
BJ028	6243464	434572				*Ster* sp.	*V. membranaceum*	
BJ029	6247319	434566					*V. ovalifolium*	
SOAP 1	6250502	437021					*S. canadensis*	

** Three replicates each*

Table 2.1-2. Summary of Soil Metal Concentration Detection Limits and CCME Guideline Soil Quality Metal Concentration Limits for Industrial Use

Parameters	CCME-I [a]	DL (mg kg^{-1})	Parameters	CCME-I [a]	DL (mg kg^{-1})
pH (1:2 soil:water)	6 to 8[b]	-	Manganese (Mn)	-	1.00
Aluminum (Al)	-	50.00	Mercury (Hg)	50	0.02
Antimony (Sb)	20	0.10	Molybdenum (Mo)	40	0.50
Arsenic (As)	12	0.05	Nickel (Ni)	50	0.50
Barium (Ba)	2,000	0.50	Phosphorus (P)	-	50.00
Beryllium (Be)	8	0.20	Potassium (K)	-	100.00
Bismuth (Bi)	-	0.20	Selenium (Se)	2.9	0.20
Cadmium (Cd)	22	0.05	Silver (Ag)	40	0.10
Calcium (Ca)	-	50.00	Sodium (Na)	-	100.00
Chromium (Cr)	87	0.50	Strontium (Sr)	-	0.50
Cobalt (Co)	300	0.10	Thallium (Tl)	1	0.05
Copper (Cu)	91	0.50	Tin (Tn)	300	2
Iron (Fe)	-	50.00	Titanium (Ti)	-	1.00
Lead (Pb)	600	0.50	Uranium (U)	300	0.05
Lithium (Li)	-	5.00	Vanadium (V)	130	0.20
Magnesium (Mg)	-	20.00	Zinc (Zn)	360	1.00
Manganese (Mn)	-	1.00			

Notes:
Except pH all units are mg/kg unless otherwise indicated.
DL = detection limit
[a] *CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial limits.*
[b] *CCME interim remediation criteria for soil.*

2.2.2 Tissue Data Analysis

Tissue metal concentrations vary with plant species, the tissue sampled, soil conditions and environmental characteristics. There are no guidelines for plant tissue metal concentrations for the tissues investigated in this project. In order to provide some perspective on the relative plant tissue metal concentration data, summary statistics (maximum, minimum, median, mean and standard deviation values) were calculated on a dry-weight basis.

For statistical summary calculations, metal concentration values that were below the detection limit were replaced with a value equivalent to half the value of the detection limit. Although this methodology for addressing what are essentially missing values does not capture the true frequency distribution of the concentrations (Nosal, Legge, and Krupa 2000), assigning values to undetected concentrations in this manner is common practice where it can be assumed the values are not zero, but where the level of risk is low enough not to warrant additional statistical analyses (i.e., with regards to human health; US EPA 2000).

Table 2.2-1. Summary of Lichen and Plant Tissue Samples Collected for Metals Analyses in 2012

Number of samples	Lichens		Berries					Wetland Sedge
Genus Species Locations	*Cladina stygia* (reindeer lichen)	*Stereocaulon tomentosum* (eyed foam lichen)	*Vaccinium ovalifolium* (oval-leaf blueberry)	*Vaccinium membranaceum* (black huckleberry)	*Vaccinium uliginosum* (bog blueberry)	*Shepherdia Canadensis* (soapberry)	*Viburnum edule* (highbush cranberry)	*Carex aquatilis* (water sedge)
Mine Site	11	-	-	-	2	-	-	-
Exploration Road	1	1	10	9	-	1	1	30
Transmission Lines	-	2	1	2	-	2	-	-
Reference	7	-	-	-	3	-	-	-
Total no of samples	**19**	**3**	**11**	**11**	**5**	**3**	**1**	**30**

Table 2.2-2. Summary of Metals Analyzed and Detection Limits for Tissue Samples, by Species, Collected in 2012

Total Metals	Units	Detection Limit	Total Metals	Units	Detection Limit
Aluminum (Al)	mg/kg	120.68	Manganese (Mn)	mg/kg	0.02
Antimony (Sb)	mg/kg	0.005	Mercury (Hg)	mg/kg	0.005
Arsenic (As)	mg/kg	0.083	Molybdenum (Mo)	mg/kg	0.02
Barium (Ba)	mg/kg	5.92	Nickel (Ni)	mg/kg	0.05
Beryllium (Be)	mg/kg	0.005	Phosphorus (P)	mg/kg	40
Boron (B)	mg/kg	1-2.	Potassium (K)	mg/kg	200
Cadmium (Cd)	mg/kg	0.01	Rubidium (Rb)	mg/kg	0.05
Calcium (Ca)	mg/kg	6	Strontium (Sr)	mg/kg	0.05
Cesium (Cs)	mg/kg	0.005	Thallium (Tl)	mg/kg	0.002
Chromium (Cr)	mg/kg	0.05	Thorium (Th)	mg/kg	0.01
Cobalt (Co)	mg/kg	0.02	Tin (Sn)	mg/kg	0.02
Copper (Cu)	mg/kg	0.05	Titanium (Ti)	mg/kg	0.05
Gallium (Ga)	mg/kg	0.02	Uranium (U)	mg/kg	0.002
Iron (Fe)	mg/kg	1	Vanadium (V)	mg/kg	0.02
Lead (Pb)	mg/kg	0.02	Yttrium (Y)	mg/kg	0.01
Magnesium (Mg)	mg/kg	10	Zinc (Zn)	mg/kg	0.5

2.2.3 Lichen Tissue Sampling and Analysis

Lichens were sampled as they are known bioaccumalators and can be used to monitor the movement and deposition of atmospheric particles and to detect resulting effects on vegetation (Garty 2000). Lichens may also be consumed by insects and animals and thus provide a link between the environment and the food chain. Results were summarized separately by species because uptake, allocation, and concentration of various metals differ by species (Garty 2001; Pugh, Dick, and Fredeen 2002; Naeth and Wilkinson 2008).

A total of 22 lichen samples were collected from the above mentioned LSA Sub-areas and Reference locations (Table 2.2-1; Figure 1-1). The two species of lichen samples collected were *Cladina stygia* (19 samples) and *Stereocaulon tomentosum*.

C. stygia samples were collected from two LSA Sub-areas, including the Mine Site (11 samples) and Access Road (one sample), and Reference locations (seven samples). *S. tomentosum* samples were collected from Access Road (one sample) and from the Reference locations (two samples).

Wherever possible, individual lichens were gathered and combined in one composite sample per site. The lichens were collected with nitrile gloves, cleaned of debris *in situ* and stored in paper bags. Lichen tissues were analyzed by ALS for % moisture and total metals, per Table 2.2-2, using methods described previously.

2.2.4 Berry Tissue Sampling and Analysis

Berry tissues were sampled for metal content as they may be consumed by animals and/or people in the Project Area. Five species of berries were sampled in 2012 and included oval leaf blueberry (*Vaccinium ovalifolium*), black huckleberry (*Vaccinium membranaceum*), bog blueberry (*Vaccinium*

uliginosum), highbush cranberry (*Vaccinium edule)* and soapberry (*Shepherdia canadensis*) was sampled. A total of 31 composite berry samples were obtained from the selected species as follows:

- *V. ovalifolium* (11 samples);
- *V. membranaceum* (11 samples);
- *V. uliginosum* (5 samples);
- *S. canadensis* (3 samples); and
- *V. edule* (1 sample).

These tissue samples were collected from four general areas as follows: Exploration Access Road (21 samples), Transmission Line - South Option (5 samples), Mine Site (2 samples), and the remaining three were from reference locations as listed in Table 2.1-1, and shown on Figures 1-1 and 2-1.

To collect a sufficient number, berries were collected from multiple plants at a site. Samples were collected while wearing nitrile gloves and were sent to ALS for analysis. The % moisture and total metals concentration was determined using same methodology as for lichen analysis. The parameters measured from the berry samples and detection limits are presented in Table 2.2-2.

2.2.5 Sedge Tissue Sampling and Analysis

In 2012, a total of 30 samples of *Carex aquatilis* (sedge), were obtained and analyzed. These tissue samples were collected from ten wetland sample sites (replicates of three from each site) located along the exploration access road (Figure 2.2-1). No sedge samples were collected from the other LSA Sub-areas or Reference locations (Table 2.1-1). Samples consisted of several leaves of the above-ground portion of the sedge plants. Plant tissues were analyzed for moisture content and total metals by ALS, by the same methods used for other tissues. The parameters measured and detection limits are presented in Table 2.2-2.

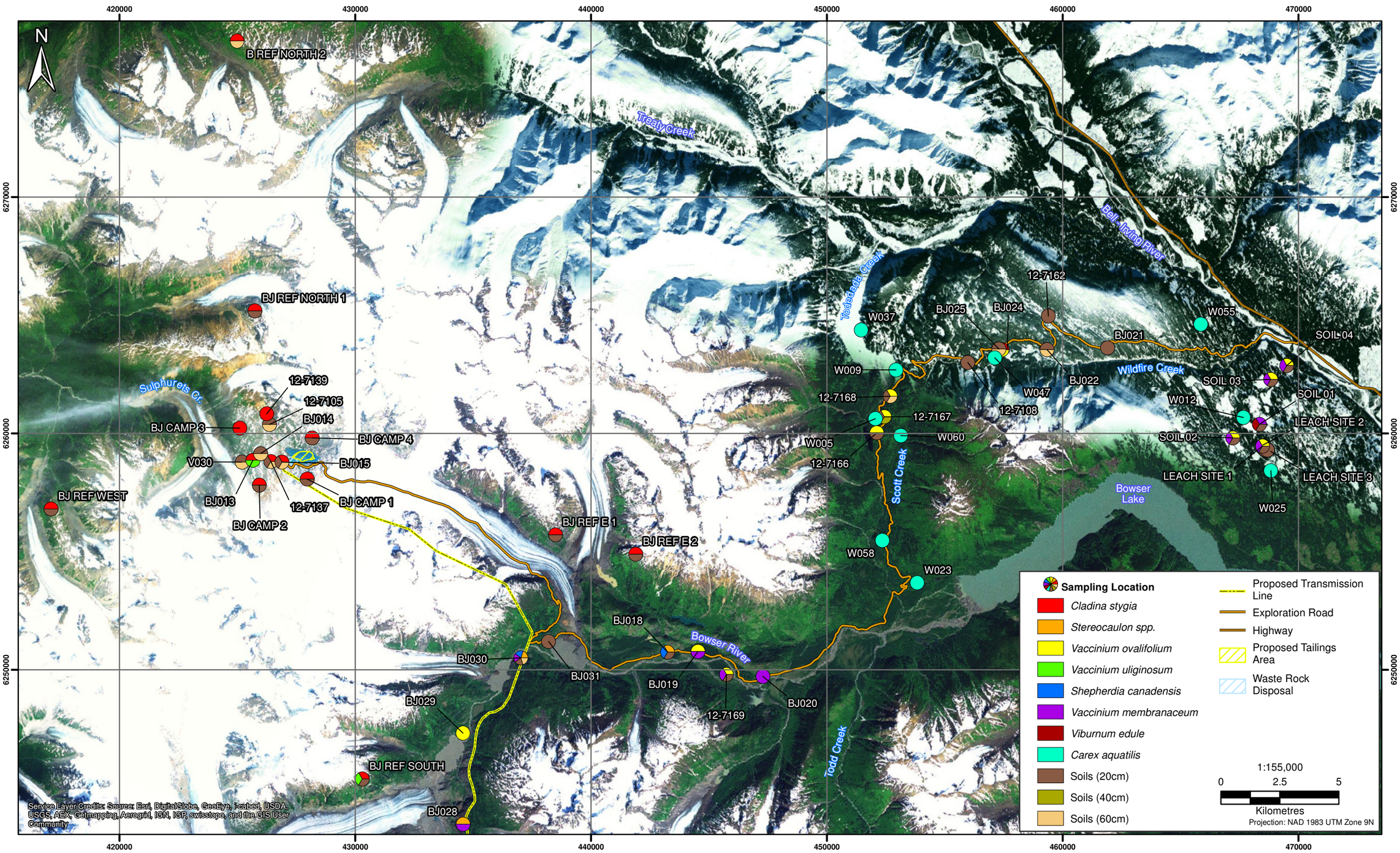

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Figure 2.2-1

Vegetation and Soil Sampling Locations for Metal Analyses

3. Results

3. Results

Results of the soil and tissue laboratory analysis are documented in the following locations within this report:

- Soil samples collected in 2012 are included in Appendix 2.
- Lichen tissue results for *Cladina stygia* and *Stereocaulon tomentosum* samples collected in 2012 are included in Appendix 3.
- Berry sample results for *Vaccinium ovalifolium, Vaccinium membranaceum, Vaccinium uliginosum, Vaccinium edule and Shepherdia canadensis* for samples collected in 2012 can be found in Appendix 4.
- Sedge sample results for *Carex* sp. samples collected from wetlands in 2012 can be found in Appendix 5.
- Summary of Lichen and Plant Tissue Analytical Results Reported on a Dry Weight Basis by LSA Sub-area and Reference locations area, Appendix 6

This report provides summary statistics (maximum, minimum, median, mean and standard deviation) for soil metal concentrations in the various LSA Sub-areas and the Reference locations area, as well as by general depth ranges, the near surface 10-20 cm depth and subsurface, 30-40 cm or 50-60 cm soil depth zones, Similar statistics are presented for tissue types moisture and metal concentrations (dry weight). For all statistical assessment, when metal concentrations are below the realized detection limit, a value equivalent to half the detection limit is used. A Photoplot record of each field sampling site is provided in Appendix 1.

3.1 SOIL ANALYTICAL RESULTS

3.1.1 Soil pH

Soil pH is an important indicator of soil health. Soil pH is affected by a number of factors including the nature of the parent material, weathering over time, changes in land use and management practices, vegetative cover, organic matter content, and local climate. Though a soil's buffering capacity tends to resist changes in pH, soil pH can change over time and space as parent material breaks down and organic acids are leached from surrounding vegetation.

In the study areas, soil pH is predominantly acidic (Tables 3.1-1), and below the interim CCME guideline for industrial use (CCME 2012) in 44 of the 49 (90%) soil samples collected. One alpine, fluvial-colluvial sample (12-7105) was found to be alkaline, and have a value marginally higher than the interim CCME guideline for industrial use (i.e., exceeds pH 8.0 by 0.1 unit). Four samples (including 1 duplicate) out of the total 48 samples are within the CCME's suitable use range of pH 6.0 to 8.0 (raw data is presented in Appendix 2).

The range of soil pH values summarized on a geographic or infrastructure basis (LSA Sub-area or Reference locations area), are more likely a reflection of the relative age of the sampling sites selected (i.e., degree of soil weathering — climate, vegetation cover interaction acting over time), than the general Sub-areas as defined, with the possible exception of the relatively small population of "Reference" locations. The observed pH distribution, though based on a very small sample population,

indicates that the samples collected from the, commonly forested, exploration access road LSA Sub-area and the high elevation or treed, Reference locations area were acidic. The two samples from the Transmission Line - South Option Sub-area were very young soils and found to be non-acidic. The extensive mid slope forested in this area are likely acidic, forest soils. At the Mine Site area 12 of the 15 samples were acidic and 3 samples were found to be neutral to alkaline. The Exploration Access Road area had some of the lowest pH (highest soil acidity) values, with the minimum being 3.82 (Table 3.1-1).

In the 10-20 cm soil depth zone, 34 out of 37 samples (92%) were found to be acidic and in the subsurface, > 30 cm to 60 cm soil depth zone, 10 out of 11 soil samples were acidic. Of the 12 soil sampling sites for which soil sampling was done for both the surface, 10-20 cm depth, and subsurface, 30-40 cm or to 50-60 cm soil depths, 10 sampling sites were acidic throughout (see Appendix 2).

3.1.2 Soil Metals

A total of 48 samples (including 3 duplicates), from 34 soil inspection sites were obtained from across the four sub- study areas (Table 3.1-1). These samples were analyzed for a suite of 31 metals, of which 19 have CCME Industrial Use Guideline criteria values (Table 3.1-2). For all the 31 metals measured had more than 50% of the samples above the detection limit. Hence all the 31 metals measured have been reported in Tables 3.1-1, 3.1-2, and 3.1-3.

Exceedances of the industrial criteria are deemed to be metals of concern in the following discussion of these 19 metals. Seven of the 19 metals were noted to exceed industrial use criteria at least once. These included the following: Sb (n = 2), As (n = 31), Cr (n = 1), Cu (n = 2), Ni (n = 8), Tl (n = 4) and V (n = 2). Soil metals not exceeding industrial use criteria include: Ba, Be, Cd, Co, Pb, Hg, Mo, Se, Ag, Sn, U, and Zn.

Arsenic is the most frequently occurring metal of concern (31 of 48 samples tested exceed the industrial guideline concentration of 12 mg kg^{-1}). Arsenic exceedances were noted at 19 of the 34 inspection sites where samples were collected. Eleven of the 12 sampled sites in the Mine Site exhibited arsenic exceedance (site BJ 31 is the exception). Reference sites commonly exhibited arsenic exceedance (4 of 6 sites). In all instances, throughout the LSA Sub-areas where samples obtained from the surface layer (nominal “20cm”) exceeded “As” criteria, the paired, underlying subsoil sample (nominally “40cm” or “60cm”) also showed exceedance. Thallium and Sb exceedance were paired with As exceedance at two sites in the Mine Site, and did not occur at any other sites. Arsenic exceedance occurred paired with Ni at one site exploration access road. BJ CAMP 2 exhibited the highest magnitude of As exceedance (883 mg/kg).

Nickel had the second highest number of soil samples exceeding the CCME guidelines. Soil nickel levels exceed CCME criteria in 8 samples from 6 sites in the LSA (exclusively within the exploration access road LSA Sub-area). Nickel exceedance occurred with other metals (As or Cr) at two sites. All samples exhibiting high Ni concentrations were within the exploration access road LSA Sub-area, consequently the highest values, the 90th percentile (67.96 mg/kg) for soil Ni, exceed the CCME guideline (50 mg/kg; Table 3.1-2).

Copper exceedance of CCME guideline limits was noted at only one site, surface and subsurface samples from Site 12-7168, located along the exploration access road. The soil concentration decreased with depth.

Chromium exceeded the CCME guideline limit in only one sample from along the exploration access road.

Table 3.1-1. Summary Statistics for Soil Samples Collected from the 20 cm Depth Zone in 2012, Brucejack Project

			Mine Site LSA					Exploration Road LSA					Transmission Line LSA	Reference Sites				
			n = 10					n = 19					n = 1	n = 7				
Parameters	CCME-I[a]	DL	Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD	Actual Values	Maximum	Minimum	Median	Mean	SD
pH (1:2 soil:water)	6 to 8[b]		7.56	4.53	5.02	5.44	1.08	5.68	3.82	4.61	4.48	0.50	6.44	5.29	4.18	4.74	4.74	0.36
Aluminum (Al)	-	50.00	37,900.00	9,790.00	18,800.00	20,449.00	7,634.27	29,100.00	10,100.00	20,900.00	20,036.84	5,646.95	16,900.00	26,400.00	12,400.00	20,400.00	19,257.14	5,222.66
Antimony (Sb)	20	0.10	17.00	1.43	3.77	6.42	5.91	3.21	0.05	0.55	0.82	0.76	1.17	6.95	0.58	1.78	2.95	2.26
Arsenic (As)	12	0.05	883.00	17.90	209.65	279.50	292.53	75.70	2.12	9.74	13.84	15.65	13.40	67.70	6.75	23.30	30.02	22.49
Barium (Ba)	2,000	0.50	118.00	48.60	92.85	89.86	25.14	132.00	43.30	83.20	87.80	28.23	46.20	296.00	46.50	98.70	113.07	84.87
Beryllium (Be)	8	0.20	1.57	0.30	0.43	0.55	0.38	0.55	0.10	0.31	0.28	0.14	0.35	1.06	0.29	0.48	0.54	0.27
Bismuth (Bi)	-	0.20	0.29	0.10	0.10	0.16	0.08	0.20	0.10	0.10	0.11	0.02	0.10	0.24	0.10	0.10	0.12	0.05
Cadmium (Cd)	22	0.05	0.28	0.08	0.13	0.17	0.08	1.15	0.10	0.25	0.31	0.27	0.56	0.38	0.12	0.21	0.21	0.09
Calcium (Ca)	-	50.00	30,400.00	477.00	1,147.00	7,112.20	12,238.99	6,740.00	182.00	579.00	1,600.47	2,011.42	3,940.00	5,350.00	597.00	1,770.00	1,970.14	1,621.58
Chromium (Cr)	87	0.50	24.90	2.93	7.00	9.10	6.83	85.30	8.67	60.50	52.88	20.27	34.30	24.20	4.25	10.50	12.59	8.86
Cobalt (Co)	300	0.10	17.10	1.85	10.27	10.77	4.64	20.60	2.10	10.30	9.45	4.58	14.50	19.30	2.92	14.20	13.35	5.26
Copper (Cu)	91	0.50	34.60	11.40	23.40	23.56	7.65	130.00	5.47	25.90	30.06	26.29	39.30	72.80	8.84	15.90	34.31	28.01
Iron (Fe)	-	50.00	51,300.00	35,900.00	42,600.00	42,530.00	5,023.73	50,400.00	10,300.00	34,100.00	34,063.16	9,919.80	38,200.00	46,900.00	35,200.00	43,100.00	42,442.86	3,650.96
Lead (Pb)	600	0.50	36.20	7.48	16.60	17.59	9.61	13.90	3.13	8.32	8.41	2.47	9.70	25.30	10.50	14.40	15.27	4.76
Lithium (Li)	-	5.00	61.40	5.30	25.05	27.22	18.25	41.60	2.50	19.00	18.97	10.51	24.00	23.20	6.70	9.70	13.04	6.02
Magnesium (Mg)	-	20.00	15,900.00	363.00	6,380.00	7,475.30	5,075.38	10,500.00	1,390.00	6,720.00	6,538.95	2,637.91	11,500.00	11,400.00	2,400.00	5,330.00	6,258.57	3,312.36
Manganese (Mn)	-	1.00	1,550.00	567.00	1,003.50	996.50	325.51	1,910.00	84.20	612.00	761.33	500.65	727.00	2,590.00	387.00	989.00	1,350.71	873.51
Mercury (Hg)	50	0.02	0.77	0.02	0.07	0.20	0.27	0.40	0.02	0.06	0.08	0.08	0.04	0.10	0.03	0.04	0.05	0.03
Molybdenum (Mo)	40	0.50	5.91	0.85	2.04	2.83	1.86	3.96	0.25	1.40	1.51	0.72	1.95	2.75	1.04	1.90	1.86	0.67
Nickel (Ni)	50	0.50	30.60	1.49	6.39	8.47	8.16	69.00	6.56	36.10	38.10	16.30	41.40	26.60	2.76	7.30	11.15	9.67
Phosphorus (P)	-	50.00	1,590.00	569.00	812.50	928.50	347.34	3,120.00	274.00	1,020.00	1,043.95	615.68	970.00	1,570.00	511.00	816.00	880.14	330.48
Potassium (K)	-	100.00	1,090.00	270.00	770.00	672.00	295.33	1,210.00	400.00	720.00	748.42	238.92	280.00	1,350.00	310.00	980.00	958.57	396.33
Selenium (Se)	2.9	0.20	1.78	0.42	0.74	0.88	0.46	2.21	0.10	0.52	0.69	0.49	0.60	1.16	0.10	0.48	0.57	0.42
Silver (Ag)	40	0.10	2.09	0.05	0.36	0.60	0.69	3.39	0.05	0.42	0.64	0.73	0.22	0.23	0.05	0.14	0.14	0.08
Sodium (Na)	-	100.00	1,380.00	50.00	50.00	189.00	418.90	120.00	50.00	50.00	56.84	20.56	50.00	240.00	50.00	50.00	85.71	71.61
Strontium (Sr)	-	0.50	34.00	2.05	7.95	15.40	12.62	39.50	2.42	6.63	12.27	11.34	16.10	42.60	5.01	12.70	16.59	12.95
Thallium (Tl)	1	0.05	1.25	0.08	0.21	0.40	0.44	0.31	0.07	0.14	0.15	0.06	0.10	0.22	0.08	0.16	0.16	0.05
Tin (Sn)	300	2.00	6.80	1.00	1.00	1.58	1.83	1.00	1.00	1.00	1.00	0.00	1.00	4.00	1.00	1.00	1.59	1.14
Titanium (Ti)	-	1.00	1,620.00	154.00	320.50	466.30	436.16	1,670.00	46.10	105.00	301.18	423.70	351.00	1,590.00	105.00	507.00	763.00	575.20
Uranium (U)	300	0.05	2.69	0.11	0.61	0.92	0.76	0.82	0.07	0.25	0.30	0.25	0.34	1.25	0.34	0.60	0.68	0.29
Vanadium (V)	130	0.20	124.00	5.85	36.40	53.12	40.90	110.00	24.60	67.70	67.86	20.61	57.00	149.00	43.20	61.20	73.36	35.15
Zinc (Zn)	360	1.00	82.90	43.30	76.65	70.52	13.09	146.00	13.70	71.60	70.91	34.56	113.00	106.00	55.30	82.60	83.20	17.66

Notes:

Except pH all units are mg/kg unless otherwise indicated.

Shaded cells indicate concentrations greater than CCME guideline levels.

DL = detection limit

[a] *CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial limits.*

[b] *CCME interim remediation criteria for soil.*

Table 3.1-2. Summary Statistics for Soil Samples Collected from the 40 cm Depth Zone in 2012, Brucejack Project

			Exploration Road LSA
			n = 1
Parameters	**CCME-I[a]**	**DL**	**Actual Values**
pH (1:2 soil:water)	**6 to 8[b]**	-	4.86
Aluminum (Al)	-	50.00	26,300
Antimony (Sb)	20	0.10	0.83
Arsenic (As)	12	0.05	13.9
Barium (Ba)	2,000	0.50	74.6
Beryllium (Be)	8	0.20	0.35
Cadmium (Cd)	22	0.05	0.272
Calcium (Ca)	-	50.00	1,440
Chromium (Cr)	87	0.50	65.9
Cobalt (Co)	300	0.10	18.4
Copper (Cu)	91	0.50	33.4
Iron (Fe)	-	50.00	50,300
Lead (Pb)	600	0.50	9.52
Lithium (Li)	-	5.00	33.7
Magnesium (Mg)	-	20.00	9,740
Manganese (Mn)	-	1.00	1,660
Mercury (Hg)	50	0.02	0.0555
Molybdenum (Mo)	40	0.50	1.88
Nickel (Ni)	50	0.50	63.8
Phosphorus (P)	-	50.00	835
Potassium (K)	-	100.00	720
Selenium (Se)	2.9	0.20	0.79
Silver (Ag)	40	0.10	0.56
Strontium (Sr)	-	0.50	14.9
Thallium (Tl)	1	0.05	0.153
Titanium (Ti)	-	1.00	189
Uranium (U)	300	0.05	0.247
Vanadium (V)	130	0.20	80.6
Zinc (Zn)	360	1.00	110

Notes:
Except pH all units are mg/kg unless otherwise indicated.
Metals for which sample concentration below detection limit: bismuth, sodium, tin.
Metals for which sample concentrations are above Detection limit are shown.
Shaded cells indicate concentrations greater than CCME guideline levels.
DL = detection limit
[a] *CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial limits.*
[b] *CCME interim remediation criteria for soil.*

Table 3.1-3. Summary Statistics for Soil Samples Collected from the 60 cm Depth Zone in 2012, Brucejack Project

			Mine Site LSA					Exploration Road LSA					Transmission Line LSA	Reference Sites
			n = 5					n = 3					n = 1	n = 1
Parameters	CCME-I[a]	DL	Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD	Actual Values	Actual Values
pH (1:2 soil:water)	6 to 8[b]		8.08	4.30	5.33	5.67	1.44	4.80	4.30	4.36	4.49	0.27	6.60	5.23
Aluminum (Al)	-	50.00	26,600.00	3,220.00	18,000.00	15,284.00	9,122.84	28,700.00	19,100.00	25,200.00	24,333.33	4,858.33	16,700.00	24,200.00
Antimony (Sb)	20	0.10	47.80	2.06	6.45	15.99	19.39	0.59	0.35	0.48	0.47	0.12	1.49	1.46
Arsenic (As)	12	0.05	384.00	18.50	203.00	192.90	160.08	9.06	7.86	8.20	8.37	0.62	14.20	26.90
Barium (Ba)	2,000	0.50	230.00	75.90	118.00	124.18	62.70	54.70	48.10	50.00	50.93	3.40	52.20	252.00
Beryllium (Be)	8	0.20	1.14	0.10	0.39	0.46	0.40	0.38	0.26	0.32	0.32	0.06	0.38	1.76
Bismuth (Bi)	-	0.20	0.27	0.10	0.10	0.13	0.08	0.10	0.10	0.10	0.10	0.00	0.10	0.10
Cadmium (Cd)	22	0.05	0.54	0.09	0.19	0.25	0.17	0.27	0.14	0.17	0.19	0.07	0.66	0.16
Calcium (Ca)	-	50.00	46,100.00	256.00	1,870.00	10,251.80	20,058.24	526.00	259.00	262.00	349.00	153.29	4,650.00	2,020.00
Chromium (Cr)	87	0.50	20.40	1.88	8.04	9.98	8.62	96.00	60.80	81.90	79.57	17.72	34.40	21.00
Cobalt (Co)	300	0.10	19.30	1.07	15.10	13.17	7.14	12.70	3.64	9.18	8.51	4.57	14.30	15.70
Copper (Cu)	91	0.50	39.70	27.00	32.60	33.22	5.24	107.00	29.30	37.90	58.07	42.60	39.80	72.20
Iron (Fe)	-	50.00	56,200.00	37,300.00	47,100.00	46,520.00	8,415.28	48,700.00	31,500.00	32,400.00	37,533.33	9,681.08	37,200.00	48,400.00
Lead (Pb)	600	0.50	83.50	9.33	13.40	36.91	35.59	10.70	5.60	7.28	7.86	2.60	9.86	19.10
Lithium (Li)	-	5.00	61.50	2.50	23.70	23.00	24.12	41.40	22.80	30.70	31.63	9.34	23.30	21.40
Magnesium (Mg)	-	20.00	16,600.00	887.00	7,080.00	6,715.40	6,439.54	10,500.00	4,570.00	9,890.00	8,320.00	3,261.89	10,700.00	4,420.00
Manganese (Mn)	-	1.00	1,960.00	142.00	1,460.00	1,248.40	692.29	887.00	123.00	419.00	476.33	385.21	815.00	1,440.00
Mercury (Hg)	50	0.02	0.97	0.03	0.08	0.26	0.40	0.17	0.07	0.08	0.11	0.06	0.06	0.18
Molybdenum (Mo)	40	0.50	6.49	1.30	1.89	3.45	2.66	1.81	1.16	1.63	1.53	0.34	1.94	1.73
Nickel (Ni)	50	0.50	30.60	1.22	7.74	10.68	11.56	73.40	36.00	72.10	60.50	21.23	40.30	24.60
Phosphorus (P)	-	50.00	1,530.00	689.00	996.00	1,044.60	314.10	1,420.00	419.00	1,110.00	983.00	512.44	1,130.00	1,370.00
Potassium (K)	-	100.00	1,170.00	300.00	580.00	662.00	361.55	650.00	540.00	600.00	596.67	55.08	390.00	1,290.00
Selenium (Se)	2.9	0.20	2.47	0.37	0.95	1.14	0.83	1.78	0.65	0.80	1.08	0.61	0.61	1.91
Silver (Ag)	40	0.10	27.80	0.05	0.31	5.83	12.29	1.15	0.44	0.99	0.86	0.37	0.23	0.14
Sodium (Na)	-	100.00	120.00	50.00	50.00	64.00	31.30	50.00	50.00	50.00	50.00	0.00	50.00	50.00
Strontium (Sr)	-	0.50	50.10	5.28	17.50	20.28	17.53	5.37	3.42	5.15	4.65	1.07	25.10	17.70
Thallium (Tl)	1	0.05	1.42	0.12	0.38	0.65	0.61	0.13	0.07	0.11	0.10	0.03	0.12	0.28
Tin (Sn)	300	2.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00
Titanium (Ti)	-	1.00	405.00	32.90	284.00	233.58	157.59	114.00	51.20	60.30	75.17	33.94	485.00	63.50
Uranium (U)	300	0.05	1.02	0.20	0.46	0.49	0.34	0.56	0.22	0.24	0.34	0.19	0.44	0.88
Vanadium (V)	130	0.20	131.00	13.20	40.00	51.60	46.55	62.80	44.80	48.30	51.97	9.54	59.30	73.40
Zinc (Zn)	360	1.00	113.00	31.60	80.60	73.24	30.34	81.80	30.80	74.90	62.50	27.67	114.00	126.00

Notes:

Except pH all units are mg/kg unless otherwise indicated.

Shaded cells indicate concentrations greater than CCME guideline levels.

DL = detection limit

[a] *CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial limits.*

[b] *CCME interim remediation criteria for soil.*

Thallium exceeded CCME limits in four samples from the Mine Site. At site 12-1705 both the surface and subsurface samples were above guideline limits. At all the four sites with elevated Tl, As was also shown to exceed CCME limits. Site 12-1705 also exhibited a Sb exceedance of the CCME guideline limit.

Vanadium exceedance was noted at two sites, as a single metal exceedance at only one site (BJ-Ref West — 20 cm), and as one of four species at the Mine Site (site 12-1705).

Multiple metal species exceedance occurred at 6 of the 34 sites and included combinations of the following: As:Ni, Cr:Ni, Sb:As:Tl:V, Sb:As. Site 12-7105 exhibited highest magnitude of As exceedance and the most metal species. Sites 12-1705 and 12-7167 showed multiple metal exceedances at both surface and sub-surface levels. Site 12-7105 at 60 cm soil depth exhibited the exceedance of most metals. Summary statistics for all plant tissue metal concentrations are included in Appendices 2 to 5. A summary of exceedances is presented in Table 3.1-4.

3.2 LICHEN TISSUE METALS

A total of 22 lichen samples (including three duplicates) were collected from within the LSA or at reference sites. The two species of lichen samples collected were black footed reindeer lichen (*Cladina stygia*) and eyed foam lichen (*Stereocaulon tomentosum*). These samples were analyzed for a suite of 39 metals (Table 3.2-1).

Metal concentration varied greatly in both *C. stygia* and *S. tomentosum*. Three of these samples, all within the Mine Site area, contained higher concentration of As than the remainder of the samples. These sites also correspond to sites with elevated As in the soils. Sample BJ CAMP2 had the highest As concentration in the lichen tissue (7.88 mg/kg). The average concentration of the As in the remainder of the samples dropped from 2.32 mg/kg to 1.52 mg/kg when this single, high value was removed. This sample site also corresponds to the highest concentration of As in the soil sample (883 mg/kg).

3.2.1 Cladina stygia

The *Cladina stygia* samples appear to be in similar concentration range but high variations can be seen within the samples from same areas. For example, Calcium, with a detection limit of 6 mg/kg, had a mean concentration at the Mine Site of 1,642 mg/kg with a standard deviation value of ± 596.03 (Table A.6-1). For the same metal the concentrations for the reference location ranged from 284 mg/kg to 1,500 mg/kg. Similar trend was observed for iron where the concentration ranged from 281 mg/kg to 1,210 mg/kg with a mean of 497.82 mg/kg, or nearly five times higher than the detection limit. High variability in metal concentration is known to exist within the plant samples. Also, the sample number on which the statistics is based is very low. More samples are required to make a statistically robust comparison between the three areas (two LSA Sub-areas and the Reference area).

Lichens absorb water and mineral nutrients from the air through the outer surface of the thallus. They are not dependent on soils for nutrients, but substrates may contribute to lichen metal concentrations. Substrate contributions may vary depending on lichen species, substrate type, and the element. The 13 *C. stygia* sample sites correspond to the soil sample sites with relatively high arsenic concentrations. Of these 13 sites, 3 lichens samples were found to have higher concentration of arsenic than rest of the samples. These three sites are located in the Mine Site area. The three lichen samples from sites 12-7137, BJ CAMP 2, and DUP 1, contained 2.40, 7.88, and 3.43 mg/kg of arsenic, respectively (Appendix 3). The average arsenic concentration for the remainder of the *C. stygia* samples from the Mine Site area was 1.36 mg/kg.

Table 3.1-4. Sampling Sites where Concentration of Metals Exceeded Regulatory Guidelines in the 20 cm, 40 cm and 60 cm Depth Zone, Brucejack Project

		Mine Site			Exploration Road Location			Transmission Line Location			Reference Location		
Metals	Depth (cm)	Percent of Samples (%)	Number of Sites	Sampling Sites	Percent of Samples (%)	Number of Sites	Sampling Sites	Percent of Samples (%)	Number of Sites	Sampling Sites	Percent of Samples (%)	Number of Sites	Sampling Sites
Antimony	20												
	40												
	60	40	2	12-1705,12-7137									
Arsenic	20	91	10	BJ014, 12-1705, BJ015, 12-7137, BJ CAMP 4, BJ CAMP 1, BJ CAMP 2, VO30, DUP1, DUP2	28	5	12-7169, 12-7166, 12-7168, 12-7167, BJ018				71	5	BJ REF SOUTH, BJ REF NORTH 2, BJ REF EAST 2, BJ REF NORTH 1, DUP3
	40				100	1	12-7167						
	60	100	5	BJ014, 12-1705, 12-7137, BJ015, V030				100	1	BJ030	100	1	BJ REF NORTH 2
Chromium	20												
	40												
	60				25	1	BJ025						
Copper	20				6	1	12-7168						
	40												
	60				25	1	12-7168						
Nickel	20				28	5	BJ022, BJ021, 12-7167, 12-7108, LEACH SITE 1						
	40				100	1	12-7167						
	60				67	2	BJ022, BJ025						
Thallium	20	18	2	12-1705, DUP2									
	40												
	60		2	BJ014, 12-1705									
Vanadium	20										14	1	BJ REF NORTH 2
	40												
	60	20	1	12-1705									

Notes:

CCME-I = CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

CSR-I = Contaminated Site Regulation (BC Reg. 375/96), Industrial Criteria

Table 3.2-1. Summary of Dry Weight Metal Concentration in Lichen Tissue Samples Collected in 2012

			Proposed Mine Site (n = 11)						Access Road (n = 2)						South Option Transmission Line (n = 2)						Reference (n = 7)					
Total Metals	Units	Detection Limit	Maximum	Minimum	Median	Mean	SD	90th Percentile	Maximum	Minimum	Median	Mean	SD	90th Percentile	Maximum	Minimum	Median	Mean	SD	90th Percentile	Maximum	Minimum	Median	Mean	SD	90th Percentile
Aluminum (Al)	mg/kg	120.68	782.00	159.00	290.00	319.45	172.42	395.00	177.00	147.00	162.00	162.00	185.71	174.00	793.00	281.00	537.00	537.00	362.04	741.80	475.00	190.00	268.00	303.29	120.68	474.80
Antimony (Sb)	mg/kg	0.01	0.38	0.05	0.07	0.10	0.09	0.10	0.02	0.01	0.01	0.01	0.10	0.02	0.03	0.03	0.03	0.03	0.00	0.03	0.07	0.02	0.04	0.04	0.02	0.07
Arsenic (As)	mg/kg	0.08	7.88	0.58	1.45	2.24	2.28	4.53	0.28	0.08	0.18	0.18	2.31	0.26	0.46	0.39	0.42	0.42	0.05	0.45	0.49	0.23	0.38	0.37	0.11	0.49
Barium (Ba)	mg/kg	5.92	62.00	7.29	14.30	23.65	17.55	40.00	26.90	6.52	16.71	16.71	20.79	24.86	21.60	13.80	17.70	17.70	5.52	20.82	28.00	10.80	14.00	16.46	5.92	27.14
Beryllium (Be)	mg/kg	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.02	0.02	0.01	0.03	0.04	0.02	0.03	0.03	0.01	0.04	0.02	0.01	0.01	0.01	0.01	0.02
Boron (B)	mg/kg	1-2.	3.50	1.00	1.80	1.98	0.77	3.30	1.60	0.50	1.05	1.05	1.04	1.49	1.90	0.50	1.20	1.20	0.99	1.76	2.20	0.50	1.40	1.39	0.54	2.15
Cadmium (Cd)	mg/kg	0.01	0.12	0.02	0.04	0.05	0.03	0.10	0.09	0.01	0.05	0.05	0.04	0.09	0.12	0.07	0.09	0.09	0.03	0.11	0.12	0.01	0.04	0.04	0.04	0.11
Calcium (Ca)	mg/kg	6.00	2,890.00	857.00	1,690.00	1,642.00	596.03	2,130.00	3,910.00	366.00	2,138.00	2,138.00	1,059.32	3,555.60	2,750.00	559.00	1,654.50	1,654.50	1,549.27	2,530.90	1,500.00	284.00	542.00	711.86	430.80	1,449.70
Cesium (Cs)	mg/kg	0.01	2.23	0.06	0.11	0.37	0.64	0.57	0.39	0.09	0.24	0.24	0.63	0.36	0.28	0.12	0.20	0.20	0.11	0.27	0.97	0.04	0.06	0.20	0.34	0.91
Chromium (Cr)	mg/kg	0.05	0.44	0.18	0.27	0.29	0.07	0.38	0.26	0.18	0.22	0.22	0.10	0.25	0.42	0.40	0.41	0.41	0.01	0.41	0.52	0.16	0.23	0.28	0.12	0.50
Cobalt (Co)	mg/kg	100-1,000	0.30	0.12	0.18	0.19	0.06	0.28	0.51	0.15	0.33	0.33	0.12	0.47	0.32	0.21	0.27	0.27	0.07	0.31	0.34	0.10	0.15	0.17	0.08	0.32
Copper (Cu)	mg/kg	0.05	2.43	1.29	1.81	1.86	0.38	2.34	2.19	1.04	1.62	1.62	0.68	2.08	6.09	3.38	4.74	4.74	1.92	5.82	1.97	0.60	1.50	1.42	0.47	1.96
Gallium (Ga)	mg/kg	0.02	0.23	0.05	0.08	0.09	0.05	0.12	0.04	0.03	0.04	0.04	0.06	0.04	0.08	0.06	0.07	0.07	0.01	0.08	0.15	0.05	0.06	0.08	0.03	0.14
Iron (Fe)	mg/kg	1.00	1,210.00	281.00	396.00	497.82	268.96	618.00	230.00	101.00	165.50	165.50	302.82	217.10	496.00	381.00	438.50	438.50	81.32	484.50	654.00	259.00	299.00	384.43	145.82	635.90
Lead (Pb)	mg/kg	0.02	3.33	0.54	0.83	1.07	0.79	1.43	0.45	0.27	0.36	0.36	0.83	0.43	0.52	0.39	0.46	0.46	0.09	0.51	1.06	0.40	0.55	0.62	0.24	1.03
Magnesium (Mg)	mg/kg	10	402.00	170.00	288.00	267.82	80.69	355.00	280.00	228.00	254.00	254.00	101.10	274.80	323.00	247.00	285.00	285.00	53.74	315.40	285.00	133.00	190.00	203.43	54.33	281.60
Manganese (Mn)	mg/kg	0.02	225.00	31.60	95.50	109.70	58.04	191.00	24.80	13.30	19.05	19.05	77.38	23.65	46.10	18.40	32.25	32.25	19.59	43.33	124.00	23.10	42.50	52.70	35.42	118.40
Mercury (Hg)	mg/kg	0.005	0.07	0.02	0.04	0.04	0.01	0.06	0.02	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.00	0.03	0.06	0.01	0.02	0.03	0.01	0.05
Molybdenum (Mo)	mg/kg	0.02	0.14	0.05	0.07	0.08	0.03	0.11	0.21	0.04	0.12	0.12	0.05	0.20	0.24	0.14	0.19	0.19	0.07	0.23	0.10	0.03	0.06	0.07	0.03	0.10
Nickel (Ni)	mg/kg	0.05	1.31	0.44	0.90	0.86	0.24	1.03	2.00	1.10	1.55	1.55	0.48	1.91	3.94	2.68	3.31	3.31	0.89	3.81	1.02	0.33	0.72	0.68	0.24	1.00
Phosphorus (P)	mg/kg	40	377.00	182.00	333.00	314.36	62.31	371.00	579.00	409.00	494.00	494.00	132.06	562.00	742.00	578.00	660.00	660.00	115.97	725.60	463.00	199.00	262.00	279.71	96.05	451.30
Potassium (K)	mg/kg	200	1,030.00	500.00	760.00	740.91	175.75	960.00	1,820.00	1,040.00	1,430.00	1,430.00	416.63	1,742.00	2,310.00	1,700.00	2,005.00	2,005.00	431.34	2,249.00	1,280.00	490.00	640.00	728.57	268.11	1,235.00
Rubidium (Rb)	mg/kg	0.05	3.00	0.87	1.58	1.64	0.63	2.05	5.15	2.41	3.78	3.78	1.28	4.88	9.23	3.61	6.42	6.42	3.97	8.67	5.28	0.86	1.40	2.15	1.51	5.01
Strontium (Sr)	mg/kg	0.05	7.16	1.98	3.42	3.99	1.65	6.09	8.09	6.21	7.15	7.15	2.43	7.90	21.20	3.13	12.17	12.17	12.78	19.39	4.82	1.48	2.36	2.81	1.13	4.71
Thallium (Tl)	mg/kg	0.002	0.03	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01
Thorium (Th)	mg/kg	0.01	0.07	0.01	0.03	0.03	0.02	0.04	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.00	0.02	0.04	0.01	0.02	0.02	0.01	0.04
Tin (Sn)	mg/kg	0.02	0.07	0.02	0.03	0.03	0.02	0.06	0.03	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.02	0.02	0.01	0.02
Titanium (Ti)	mg/kg	0.05	29.80	6.31	13.80	15.51	6.70	21.50	10.00	2.44	6.22	6.22	7.96	9.24	16.80	16.10	16.45	16.45	0.49	16.73	31.70	5.17	11.40	13.83	9.31	30.54
Uranium (U)	mg/kg	0.002	0.02	0.01	0.01	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.00	0.01	0.01	0.00	0.02
Vanadium (V)	mg/kg	0.02	1.79	0.52	0.84	0.89	0.34	1.06	0.50	0.21	0.36	0.36	0.43	0.47	0.89	0.82	0.86	0.86	0.05	0.88	1.74	0.54	0.71	0.86	0.42	1.66
Yttrium (Y)	mg/kg	0.01	0.23	0.08	0.14	0.16	0.05	0.23	0.09	0.05	0.07	0.07	0.07	0.08	0.44	0.35	0.40	0.40	0.07	0.43	0.22	0.08	0.11	0.13	0.05	0.22
Zinc (Zn)	mg/kg	0.5	20.00	5.78	11.70	11.85	4.60	18.20	18.20	11.30	14.75	14.75	5.51	17.51	22.10	19.40	20.75	20.75	1.91	21.83	20.50	5.78	8.92	10.89	5.06	19.75

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: rhenium, sodium and tellurium.

Parameters with more than 50% of samples below detection limit: bismuth, lithium, selenium and zirconium.

3.2.2 Stereocaulon tomentosum

Three *Stereocaulon tomentosum* (Eyed Foam Lichen) samples were collected in 2012, two from the South Option Transmission Line area and one from the exploration access road area (see summary in Table A.6-2).

Metals which were not detected in these samples included rhenium, sodium, tellurium, bismuth, lithium, selenium and zirconium. Similar to *C. stygia*, metal concentrations in the *S. tomentosum* samples varied greatly between these three samples. For example the concentrations of calcium, iron, phosphorous, and potassium metals were found to be way higher than the detection limit but more samples are required to draw any definitive statistical conclusion.

3.3 BERRY TISSUE METALS

A total of 31 berry samples were collected. Five species were targeted for sampling including oval leaf blueberry (*Vaccinium ovalifolium*), black huckleberry (*Vaccinium membranaceum*), bog blueberry (*Vaccinium uliginosum*), highbush cranberry (*Vaccinium edule)* and soapberry (*Shepherdia canadensis*). Twenty-one samples were collected from the exploration access road, five from the Transmission Line - South Option, two from the Mine Site and three from the Reference locations. Summaries of metals present in berries are given in Table 3.3-1.

3.3.1 Vaccinium ovalifolium

A total of 11 *Vaccinium ovalifolium* (oval-leaf berry) berry samples were collected in 2012 from the exploration access road and Transmission Line - South Option. Summary statistics for dry weight metal concentrations from exploration access road and dry weight metal concentrations from Transmission Line - South Option are presented in Table A.6-3. No *V. ovalifolium* sample was analyzed from Mine Site and Reference locations. The table list summary statistics and dry weight metal concentrations for metals which were detected in more than 50% of the samples. Parameters which fell below the detection limit in all samples, or in more than 50% of the samples are not indicated in the tables. Thirty metals were measured in all the 11 samples but only 14 metals had greater than 50 % of samples concentration higher than the detection limit. Metals antimony, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, lead, lithium, mercury, selenium, sodium, thallium, titanium, uranium and vanadium have not been included in the table as sample concentration fell below the detection limit in all samples, or in more than 50% of the samples in these metals.

In the *V. ovalifolium* berry samples, of the 14 reported metals the highest concentrations of only four metals was measured in the samples from the South Option Transmission Line (n = 1) and rest of the metals highest concentration was measured in samples collected from exploration access road location.

3.3.2 Vaccinium membranaceum

A total of 11 *Vaccinium membranaceum* (black huckleberry) berry samples were collected in 2012 from the exploration access road and South Option Transmission Line. Summary statistics for dry weight metal concentrations from these locations are presented in Table A.6-4. No *V. membranaceum* sample was analyzed from Mine Site and Reference locations. The table list summary statistics of dry weight metal concentrations for metals which were detected in more than 50% of the samples. Thirty metals were measured in all the 11 samples but only 14 metals had greater than 50 % of samples concentration higher than the detection limit. Metals antimony, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, lead, lithium, mercury, selenium, sodium, thallium, titanium, uranium and vanadium have not been included in the table as sample concentration fell below the detection limit in all samples, or in more than 50% of the samples in these metals.

In the *V. membranaceum* berry samples, of the 14 reported metals the highest concentrations of 13 metals was measured in the samples from the South Option Transmission Line (n = 2) whereas highest concentration of only 1 metal was measured in samples collected from exploration access road area.

3.3.3 Vaccinium uliginosum

A total of five *Vaccinium uliginosum* (Bog blueberry) berry samples were collected in 2012 from the Mine Site and Reference areas. Summary statistics for dry weight metal concentrations from these two locations are presented in Table 3.3-2. No *V. uliginosum* samples were analyzed from exploration access road and South Option Transmission Line. The table lists summary statistics and dry weight metal concentrations for metals which were detected in more than 50% of the samples.

Parameters which fell below the detection limit in all samples, or in more than 50% of the samples, are not indicated in the tables. Metals with highest overall concentrations were calcium, magnesium, Iron, phosphorus and potassium. Of the terrestrial plant tissues sampled, the berry samples had the lowest concentrations of the elements measured.

In the *Vaccinium uliginosum* berry samples, of the 14 reported metals the highest concentrations of nine metals was measured in the samples from the Reference location (n = 3) whereas highest concentration of remaining five metals were measured in samples collected from Mine Site location (n = 2; Table 3.3-2). The highest metal concentrations occurred at different sites from within the location depending on the metal.

3.3.4 Viburnum edule

One *Viburnum edule* (highbush cranberry) berry samples were collected in 2012 from the exploration access road location. Dry weight metal concentrations from this location are presented in Table 3.3-3. No *V. edule* samples were analyzed from exploration access road, South Option Transmission Line and Reference locations. The table list actual dry weight metal concentrations for metals were above the detection limit. Parameters which fell below the detection limit are not indicated in the tables. Metals antimony, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, lead, lithium, mercury, selenium, sodium, thallium, titanium, uranium and vanadium have not been included in the table as sample concentration fell below the detection limit these metals.

3.3.5 Shepherdia canadensis

A total of three *Shepherdia canadensis* (soapberry) berry samples were collected in 2012 from the exploration access road and South Option Transmission Line areas. Summary statistics for dry weight metal concentrations from these locations are presented in Table 3.3-4. No *S. canadensis* sample was analyzed from Mine Site and Reference locations. The table list summary statistics and dry weight metal concentrations for metals which were detected in more than 50% of the samples. Thirty metals were measured in all the three samples but only 14 metals had greater than 50% of samples concentration higher than the detection limit. Metals antimony, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, lead, lithium, mercury, selenium, sodium, thallium, titanium, uranium and vanadium have not been included in the table as sample concentration fell below the detection limit in all samples, or in more than 50% of the samples in these metals.

In the *S. canadensis* berry samples, of the 14 reported metals the highest concentrations of all the 14 metals was measured in the samples from the South Option Transmission Line (n = 2) and none of the metal had higher concentration in the one sample analyzed from the exploration access road location (Table 3.3-4).

Table 3.3-1. Summary of Dry Weight Metal Concentration in Berry Tissue Samples Collected in 2012

			Proposed Mine Site (n = 2)						Access Road Location (n = 21)						South Option Transmission Line (n = 5)						Reference (n = 3)					
Total Metals	Units	Detection Limit	Maximum	Minimum	Median	Mean	SD	90th Percentile	Maximum	Minimum	Median	Mean	SD	90th Percentile	Maximum	Minimum	Median	Mean	SD	90th Percentile	Maximum	Minimum	Median	Mean	SD	90th Percentile
Aluminum (Al)	mg/kg	10.00	23.00	13.00	18.00	18.00	7.07	22.00	62.00	5.00	29.00	26.71	12.87	37.00	49.00	5.00	12.00	20.60	19.35	42.20	21.00	19.00	20.00	20.00	1.00	20.80
Barium (Ba)	mg/kg	0.05	11.50	10.40	10.95	10.95	0.78	11.39	25.90	1.11	13.70	13.88	5.81	20.20	38.10	3.42	4.76	13.67	14.93	30.06	25.20	19.20	22.70	22.37	3.01	24.70
Calcium (Ca)	mg/kg	10.00	2,130.00	1,770.00	1,950.00	1,950.00	254.56	2,094.00	5,060.00	678.00	1,230.00	1,391.10	882.91	1,650.00	2,380.00	949.00	2,220.00	1,877.80	614.28	2,344.00	1,830.00	1,280.00	1,620.00	1,576.67	277.55	1,788.00
Copper (Cu)	mg/kg	0.05	3.76	3.41	3.59	3.59	0.25	3.73	8.78	1.31	4.71	4.69	1.68	6.48	6.35	4.36	5.35	5.18	0.82	5.97	3.55	2.54	3.05	3.05	0.51	3.45
Iron (Fe)	mg/kg	1.00	18.00	12.00	15.00	15.00	4.24	17.40	51.00	5.00	18.00	20.38	10.00	31.00	44.00	21.00	26.00	28.64	9.13	38.08	20.00	19.00	19.00	19.33	0.58	19.80
Magnesium (Mg)	mg/kg	3.00	597.00	568.00	582.50	582.50	20.51	594.10	825.00	306.00	593.00	595.57	123.54	730.00	775.00	514.00	522.00	600.60	118.97	735.00	622.00	473.00	546.00	547.00	74.51	606.80
Manganese (Mn)	mg/kg	0.05	130.00	125.00	127.50	127.50	3.54	129.50	450.00	8.94	182.00	217.64	114.66	370.00	274.00	18.60	19.90	100.50	117.17	232.80	128.00	50.00	116.00	98.00	42.00	125.60
Molybdenum (Mo)	mg/kg	0.05	0.03	0.03	0.03	0.03	0.00	0.03	1.70	0.03	0.16	0.28	0.36	0.46	1.25	0.05	0.37	0.50	0.49	1.04	0.09	0.03	0.09	0.07	0.04	0.09
Nickel (Ni)	mg/kg	0.50	0.59	0.25	0.42	0.42	0.24	0.56	3.03	0.25	0.72	0.83	0.60	1.16	9.16	0.69	2.36	3.58	3.56	7.48	0.84	0.59	0.74	0.72	0.13	0.82
Phosphorus (P)	mg/kg	20-200	1,170.00	972.00	1,071.00	1,071.00	140.01	1,150.20	2,350.00	740.00	1,310.00	1,419.52	388.10	1,830.00	2,000.00	1,470.00	1,730.00	1,730.00	199.12	1,928.00	1,390.00	1,220.00	1,230.00	1,280.00	95.39	1,358.00
Potassium (K)	mg/kg	100-1,000	7,500.00	6,190.00	6,845.00	6,845.00	926.31	7,369.00	10,300.00	4,700.00	6,290.00	6,602.38	1,487.73	8,200.00	9,800.00	6,000.00	7,300.00	7,490.00	1,474.96	9,020.00	6,500.00	6,400.00	6,400.00	6,433.33	57.74	6,480.00
Strontium (Sr)	mg/kg	0.05	6.08	5.17	5.63	5.63	0.64	5.99	12.80	1.45	3.02	4.40	3.13	9.38	8.22	4.64	5.65	6.17	1.41	7.70	13.90	2.59	2.83	6.44	6.46	11.69
Tin (Sn)	mg/kg	0.20	1.21	0.10	0.66	0.66	0.78	1.10	2.74	0.10	0.93	0.93	0.65	1.62	1.31	0.10	1.03	0.89	0.49	1.29	1.29	0.59	0.91	0.93	0.35	1.21
Zinc (Zn)	mg/kg	0.50	19.00	17.00	18.00	18.00	1.41	18.80	15.30	4.28	7.50	7.94	2.40	10.60	12.30	8.40	11.40	10.64	1.85	12.26	21.40	17.20	19.10	19.23	2.10	20.94

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: antimony, arsenic, beryllium, bismuth, chromium,cobalt, lithium, selenium, sodium, thallium, uranium and vanadium.

Parameters with more than 50% of samples below detection limit: cadmium,lead, mercury, titanium.

Table 3.3-2. Summary of Dry Weight Metal Concentration in *V. uliginosum* Tissue Samples Collected in 2012

Total Metals	Units	Detection Limit	Reference Location (n = 3)					Mine Site Location (n = 2)				
			Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD
Aluminum (Al)	mg/kg	10	21.00	19.00	20.00	20.00	1.00	23.00	13.00	18.00	18.00	7.07
Barium (Ba)	mg/kg	0.05	25.20	19.20	22.70	22.37	3.01	11.50	10.40	10.95	10.95	0.78
Calcium (Ca)	mg/kg	10	1,830.00	1,280.00	1,620.00	1,576.67	277.55	2,130.00	1,770.00	1,950.00	1,950.00	254.56
Copper (Cu)	mg/kg	0.05	3.55	2.54	3.05	3.05	0.51	3.76	3.41	3.59	3.59	0.25
Iron (Fe)	mg/kg	1	20.00	19.00	19.00	19.33	0.58	18.00	12.00	15.00	15.00	4.24
Magnesium (Mg)	mg/kg	3	622.00	473.00	546.00	547.00	74.51	597.00	568.00	582.50	582.50	20.51
Manganese (Mn)	mg/kg	0.05	128.00	50.00	116.00	98.00	42.00	130.00	125.00	127.50	127.50	3.54
Molybdenum (Mo)	mg/kg	0.05	0.09	0.03	0.09	0.07	0.04	0.03	0.03	0.03	0.03	0.00
Nickel (Ni)	mg/kg	0.5	0.84	0.59	0.74	0.72	0.13	0.59	0.25	0.42	0.42	0.24
Phosphorus (P)	mg/kg	20-200	1,390.00	1,220.00	1,230.00	1,280.00	95.39	1,170.00	972.00	1,071.00	1,071.00	140.01
Potassium (K)	mg/kg	100-1,000	6,500.00	6,400.00	6,400.00	6,433.33	57.74	7,500.00	6,190.00	6,845.00	6,845.00	926.31
Strontium (Sr)	mg/kg	0.05	13.90	2.59	2.83	6.44	6.46	6.08	5.17	5.63	5.63	0.64
Tin (Sn)	mg/kg	0.2	1.29	0.59	0.91	0.93	0.35	1.21	0.10	0.66	0.66	0.78
Zinc (Zn)	mg/kg	0.5	21.40	17.20	19.10	19.23	2.10	19.00	17.00	18.00	18.00	1.41

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: antimony, arsenic, beryllium, bismuth, chromium,cobalt, lithium, selenium, sodium, thallium, uranium and vanadium.

Parameters with more than 50% of samples below detection limit: cadmium,lead, mercury, titanium.

Table 3.3-3. Summary of Dry Weight Metal Concentration in *V. edule* Tissue Sample Collected in 2012

Total Metals	Units	Detection Limit	Exploration Road Location Actual values (n = 1)
Aluminum (Al)	mg/kg	10	5.00
Barium (Ba)	mg/kg	0.05	10.50
Calcium (Ca)	mg/kg	10	1,470.00
Copper (Cu)	mg/kg	0.05	1.31
Iron (Fe)	mg/kg	1	5.00
Magnesium (Mg)	mg/kg	3	402.00
Manganese (Mn)	mg/kg	0.05	15.40
Molybdenum (Mo)	mg/kg	0.05	0.03
Nickel (Ni)	mg/kg	0.5	0.25
Phosphorus (P)	mg/kg	20-200	740.00
Potassium (K)	mg/kg	100-1,000	6,900.00
Strontium (Sr)	mg/kg	0.05	12.80
Tin (Sn)	mg/kg	0.2	0.69
Zinc (Zn)	mg/kg	0.5	7.04

Notes: Only parameters with concentrations above detection limits in more than 50% of the samples listed.
Parameters with concentration of all samples below the detection limit: antimony, arsenic, beryllium, bismuth, chromium, cobalt, lithium, selenium, sodium, thallium, uranium and vanadium.
Parameters with more than 50% of samples below detection limit: cadmium, lead, mercury, titanium.

Table 3.3-4. Summary of Dry Weight Metal Concentration in *S. canadensis* Tissue Samples Collected in 2012

			Transmission Line - South Option Area (n = 2)					Exploration Road Location Actual Values (n = 1)
Total Metals	Units	Detection Limit	Maximum	Minimum	Median	Mean	SD	
Aluminum (Al)	mg/kg	10	12.00	5.00	8.50	8.50	4.95	5.00
Barium (Ba)	mg/kg	0.05	4.07	3.42	3.75	3.75	0.46	1.11
Calcium (Ca)	mg/kg	10	2,290.00	949.00	1,619.50	1619.50	948.23	678.00
Copper (Cu)	mg/kg	0.05	5.41	4.36	4.89	4.89	0.74	3.32
Iron (Fe)	mg/kg	1	44.00	29.20	36.60	36.60	10.47	20.00
Magnesium (Mg)	mg/kg	3	522.00	514.00	518.00	518.00	5.66	306.00
Manganese (Mn)	mg/kg	0.05	19.90	18.60	19.25	19.25	0.92	8.94
Molybdenum (Mo)	mg/kg	0.05	1.25	0.72	0.98	0.98	0.38	0.48
Nickel (Ni)	mg/kg	0.5	9.16	4.95	7.06	7.06	2.98	3.03
Phosphorus (P)	mg/kg	20-200	1,820.00	1,730.00	1,775.00	1,775.00	63.64	1,500.00
Potassium (K)	mg/kg	100-1,000	9,800.00	7,850.00	8,825.00	8,825.00	1,378.86	7,700.00
Strontium (Sr)	mg/kg	0.05	5.65	5.42	5.54	5.54	0.16	3.21
Tin (Sn)	mg/kg	0.2	0.77	0.10	0.44	0.44	0.47	0.43
Zinc (Zn)	mg/kg	0.5	12.30	11.40	11.85	11.85	0.64	7.11

Notes: Only parameters with concentrations above detection limits in more than 50% of the samples listed.
Parameters with concentration of all samples below the detection limit: antimony, arsenic, beryllium, bismuth, chromium, cobalt, lithium, selenium, sodium, thallium, uranium and vanadium.
Parameters with more than 50% of samples below detection limit: cadmium, lead, mercury, titanium.

Averaging the metal concentrations over the locations, it was observed that *V. membranaceum* had higher average dry weight metal concentration for 6 of the 14 metals compared to rest of the species. *S. canadensis* had highest concentration in 5 metals whereas *V. ovalifolium*, *V. uliginosum* and *V. edule* had higher concentration in one metal each.

Berry plants showed a slightly different trend than the lichen plants. Berry samples from within each sub study area had As below the detection limit. Of the 14 metals having concentrations above the detection limit, nine metals (Al, Ba, Ca, Fe, Mg, Mo, Ni, P and K) had highest 90th percentile value in the Transmission Line – South Option area (Table 3.3-1). No metals had higher 90th percentile in the berry samples from Mine Site.

At 25 sites both the soil and plant samples were collected. At two sites (BJ030 and BJ REF EAST 1) soil, lichen, and berry samples were collected. In BJ REF EAST 1 none of the metals exceeded the limit in any of the three sample types. In the BJ030 though soil sample were slightly exceeded the CCME guideline limit at both the soil depths but this was not observed in the plant samples.

Within the Mine Site LSA where soil samples at eight sites ranged from high to very high corresponding plant lichen samples in 5 locations exhibited high As concentration. This was not observed in other sites or locations where the soils were high in As. Sample 12-7168, along the exploration access road, was found to be high in Cu in both the soil as well as plant lichen.

Soils in the LSA are mainly acidic in nature. Increased acidity causes liberation of trace metals, including arsenic. Increased concentration of As in the soils could be due to decreased soil pH. Also, As occurs naturally in form of sulphide ores in the earth. Since valuable metals such as gold can also be found in sulphide mineral deposits any area high in gold (and copper) will have correspondingly high concentration of As. High As in some of the plant samples could be due to the very high concentration found in the soils of those areas.

3.4 WETLAND SEDGE TISSUE METALS

Ten *Carex aquatilis* (sedge) tissue samples were collected from exploration access road location. There were three replicates per sample. The sedge samples were analyzed for 25 different metals many of which were below detection limits. Table 3.4-1 lists summary statistics for metals which were above the detection limits in more than 50% of the samples (barium, calcium, cobalt, copper, magnesium, manganese, molybdenum, nickel, strontium, zinc). The metals antimony, beryllium, bismuth, chromium, lead, lithium, selenium, tin, uranium, vanadium were not detected in any sedge tissue samples. The metals aluminum, arsenic, cadmium, mercury, thallium were detected in less than 50% of the samples. Metals with highest overall concentrations were calcium, magnesium and manganese.

Table 3.4-1. Summary of Dry Weight Metal Concentration in Sedge Tissue Samples Collected in 2012

			Access Road (n = 10)					
Total Metals	Units	Detection Limit	Maximum	Minimum	Median	Mean	SD	90th Percentile
Barium (Ba)	mg/kg	0.050	23.80	4.10	12.30	23.80	4.61	18.37
Calcium (Ca)	mg/kg	10.000	8,520.00	1,180.00	2,050.00	8,520.00	1,650.32	4,556.00
Cobalt (Co)	mg/kg	0.100	0.63	0.05	0.11	0.63	0.17	0.45
Copper (Cu)	mg/kg	0.050	21.80	0.92	4.58	21.80	5.06	10.10
Magnesium (Mg)	mg/kg	3.000	1,890.00	876.00	1,350.00	1,890.00	221.00	1,590.00
Manganese (Mn)	mg/kg	0.050	1,140.00	96.70	275.00	1,140.00	244.17	673.00
Molybdenum (Mo)	mg/kg	0.050	0.99	0.03	0.22	0.99	0.27	0.67
Nickel (Ni)	mg/kg	0.500	6.21	0.25	1.56	6.21	1.41	2.88
Strontium (Sr)	mg/kg	0.050	60.40	5.41	17.35	60.40	11.91	30.71
Zinc (Zn)	mg/kg	0.500	55.90	19.00	37.05	55.90	10.18	50.73

Note:
Only parameters with concentrations above detection limits in more than 50% of the samples listed.

References

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References

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Garty, J. 2000. *Chapter 8 Environment and Elemental Content of Lichens*. Trace Metals in the Environment 4: 245-276.

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Appendix 1

Photographic Record of Sample Collection Sites

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Appendix 1. Photographic Record of Sample Collection Sites

As part of the proposed Brucejack Gold Mine Project (the Project) baseline studies and in partial fulfillment of the permit application, soil, lichens, berries, and plant tissue samples were collected to establish baseline metal concentrations. Tracking metal concentrations is a commitment made during the mine permit application and is used to guide reclamation planning and establishing end land use objectives (BC Ministry of Energy and Mines 1998). The metals analyses determines baseline metal levels in the area of proposed infrastructure as well as at control sites outside of the expected zone of influence of project environmental effects.

This document provides a Photoplot Record of the collected species as well as the metals site locations. Results from the baseline metals analysis may be used for country foods assessments and/or future monitoring programs.

STUDY AREA

Samples were collected from within a Local Study Area (LSA) and at reference sites outside of the LSA. The LSA was divided into three separate areas for the purposes of the terrestrial baseline studies because of the variety of landforms and vegetation types present in the LSA, the different types of effects that may result from the various infrastructure components, and the relatively large geographical separation among some of the various infrastructure components. The three study areas within the LSA (and the reference site) include the following:

- The Mine Site;
- The Access Road;
- The Transmission Line; and
- Reference (outside of the LSA).

TARGET SPECIES

Five fruit bearing shrubs and two lichen species were targeted for collection in 2012 based on the following criteria:

- frequency of occurrence/ease of collection;
- known bio-accumulator; and
- likelihood of food source for animals.

The species collected include oval leaf blueberry (*Vaccinium ovalifolium;* Plate 1-1*)*, black huckleberry (*Vaccinium membranaceum;* Plate 1-2), bog blueberry (*Vaccinium uliginosum;* Plate 1-3), soapberry (*Sheperdia* canadensis; Plate 1-4), highbush cranberry (*Viburnum edule;* Plate 1-5), black footed reindeer lichen (*Cladina stygia*; Plate 1-6) and eyed foam lichen (*Stereocaulon tomentosum*; Plate 1-7).

TARGET LOCATIONS

Sites were targeted for collection based on the following criteria:

- potential to interact directly or indirectly with the Project (with the exception of the reference sites);

- soils suitability for reclamation characterization; and
- presence of target species.

Plate 1-1. Vaccinium ovalifolium *(oval leaf blueberry).*

Plate 1-2. Vaccinium membranaceum *(black huckleberry).*

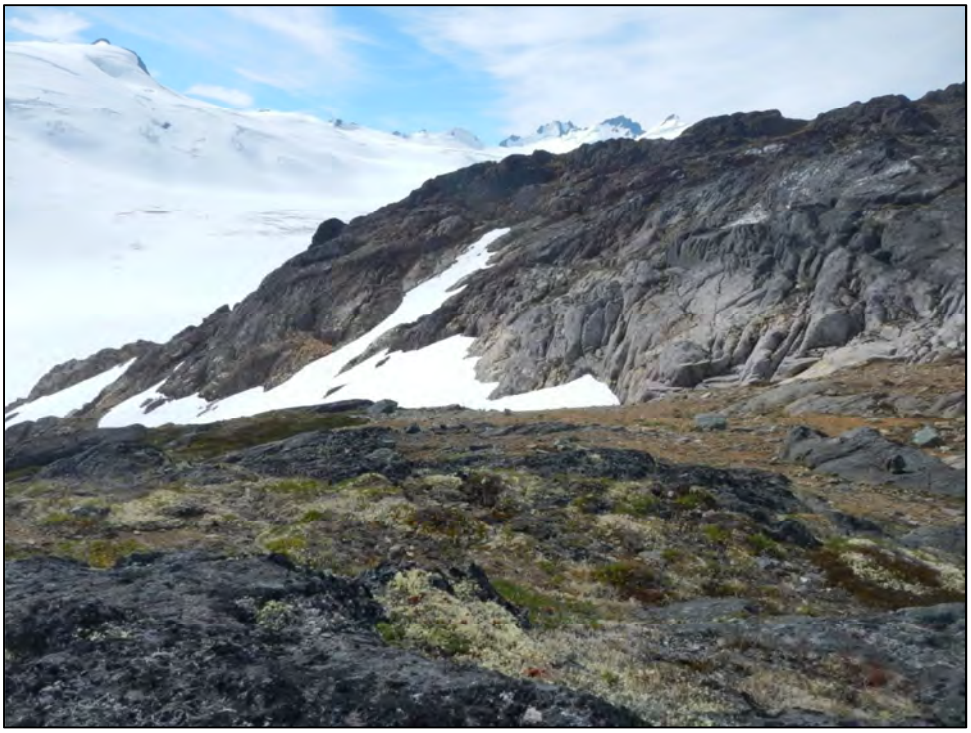
Plate 1-3. Vaccinium uliginosum *(bog blueberry)*.

Plate 1-4. Sheperdia canadensis *(soapberry)*.

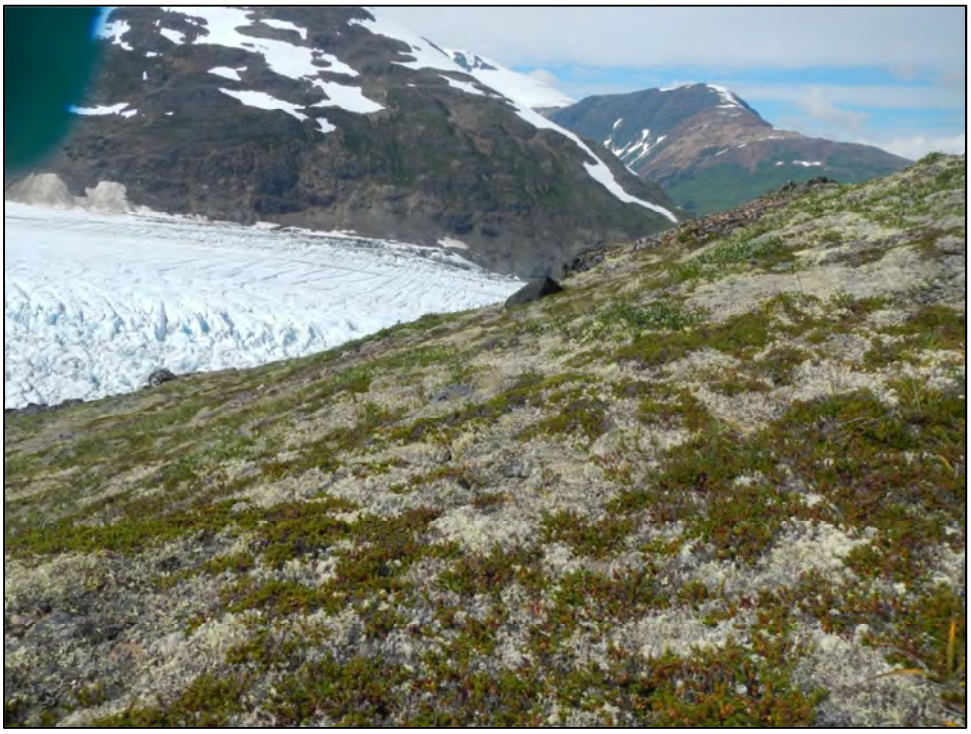
Plate 1-5. Viburnum edule *(highbush cranberry).*

Plate 1-6. Cladina stygia *(black footed reindeer lichen).*

Plate 1-7. Stereocaulon tomentosum *(Eyed Foam Lichen)*.

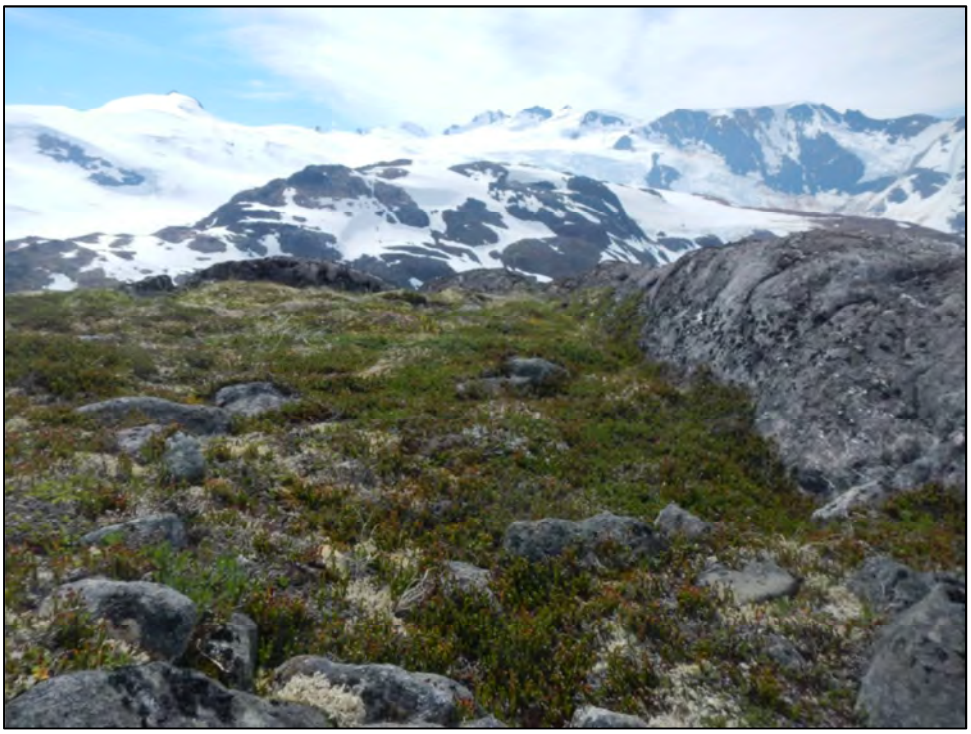


Site Name and Location: BJ Camp 1 (6258065, 427964)
Samples Collected: Soils (20 cm); *Cladina stygia* (black footed reindeer lichen)



Site Name and Location: BJ Camp 2 (6257808, 425935)
Samples Collected: Soils (20 cm); *Cladina stygia* (black footed reindeer lichen)

Site Name and Location: BJ Camp 3 (6260220, 425105)
Samples Collected: *Cladina stygia* (black footed reindeer lichen)



Site Name and Location: BJ Camp 4 (6259804, 428178)
Samples Collected: Soils (20 cm); *Cladina stygia* (black footed reindeer lichen)

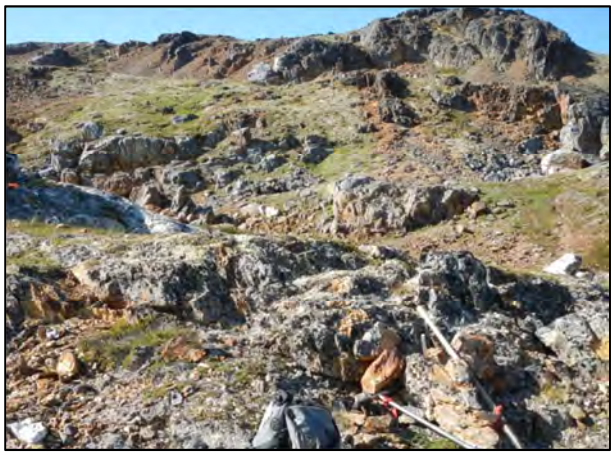
Site Name and Location: Leach Site 1 (6259461, 468472)
Samples Collected: Soils (20 cm); *Vaccinium ovalifolium* (oval leaf blueberry); *Vaccinium membranaceum* (black huckleberry)

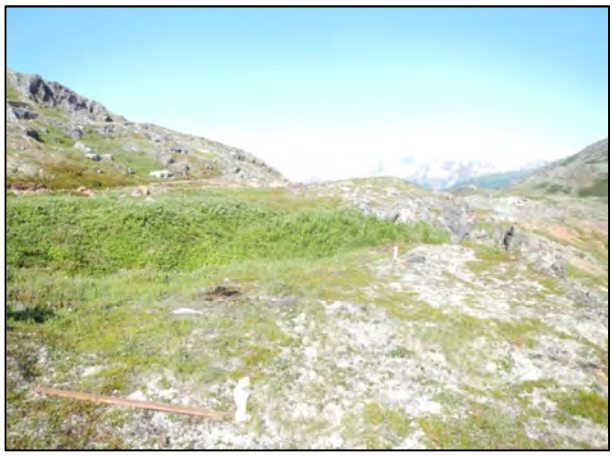
Site Name and Location: Leach Site 2 (6259290, 468619)
Samples Collected: Soils (20 cm)

Site Name and Location: Leach Site 3 (6259296, 468683)
Samples Collected: Soils (20 cm)

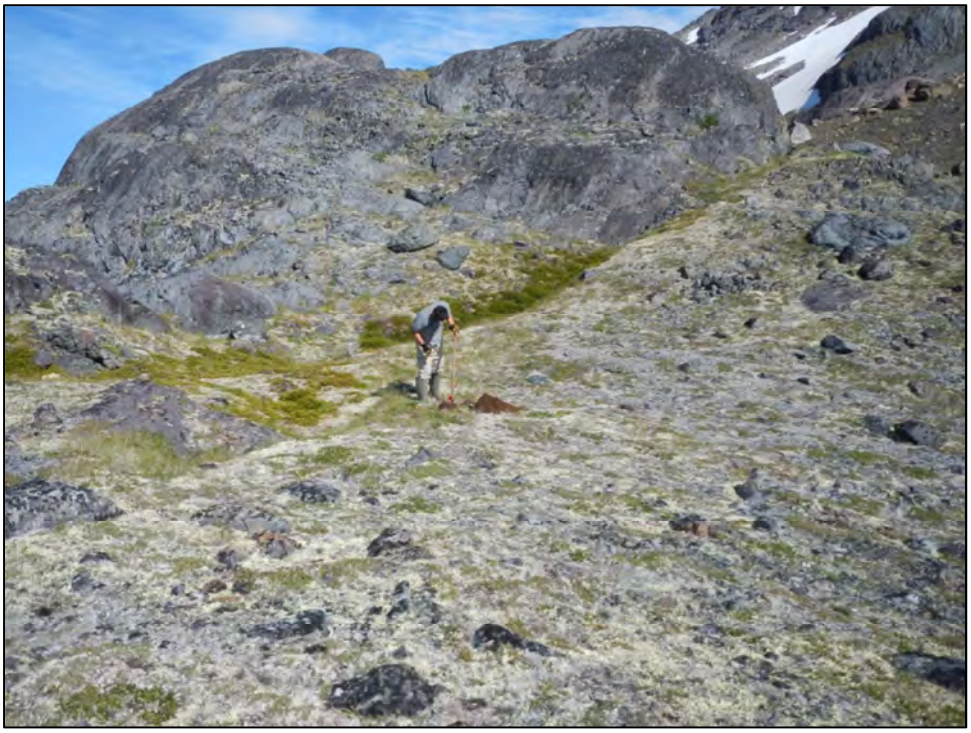
Site Name and Location: 12-7105
Samples Collected: Soils (20 cm and 60cm)

Site Name and Location: 12-7108 (6262995, 455975)
Samples Collected: Soils (20 cm)





Site Name and Location: 12-7137 (BJ013; 6258807, 426423)
Samples Collected: Soils (20 cm and 60 cm); *Cladina stygia* (black footed reindeer lichen)



Site Name and Location: 12-7139 (6260834, 426250)
Samples Collected: *Cladina stygia* (black footed reindeer lichen)

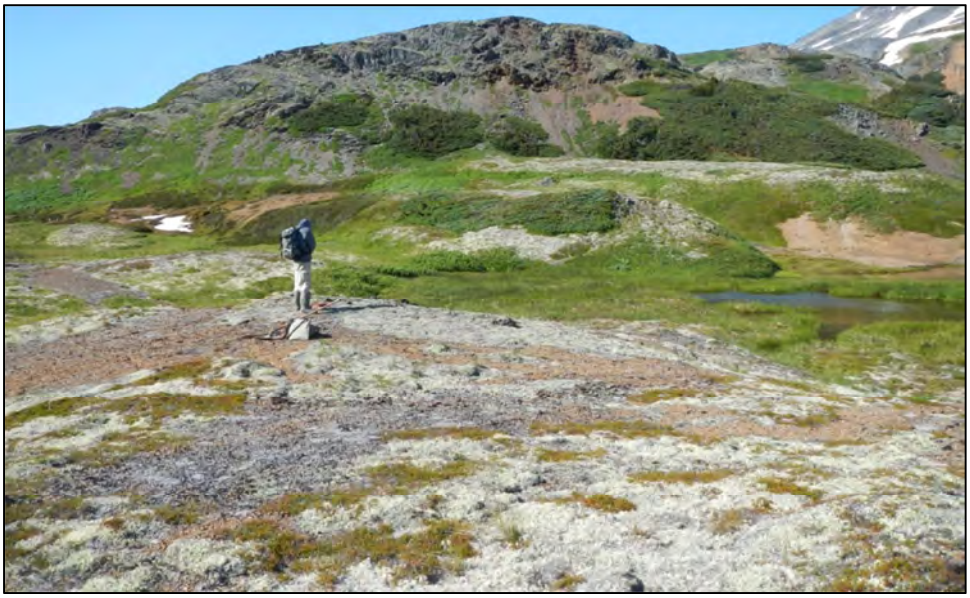
Site Name and Location: 12-7162 (6264963, 459391)
Samples Collected: Soils (20cm)

Site Name and Location: 12-7166 (6260024, 45218)
Samples Collected: Soils (20 cm); *Vaccinium ovalifolium* (oval leaf blueberry)

Site Name and Location: 12-7167 (6260702, 450441)
Samples Collected: Soils (20 cm and 40cm); *Vaccinium ovalifolium* (oval leaf blueberry)

Site Name and Location: 12-7168 (6261576, 452690)
Samples Collected: Soils (20 cm and 60cm); *Vaccinium ovalifolium* (oval leaf blueberry)

Site Name and Location: 12-7169 (6249799, 445738)
Samples Collected: Soils (20 cm); *Vaccinium ovalifolium* (oval leaf blueberry); *Vaccinium membranaceum* (black huckleberry)



Site Name and Location: BJ014 (6259142, 425991)
Samples Collected: Soils (20 cm and 60 cm)

Site Name and Location: BJ015 (6258785, 426894)|
Samples Collected: Soils (20 cm and 60 cm); *Cladina stygia* (black footed reindeer lichen)

Site Name and Location: BJ018 (6250744, 443244)
Samples Collected: Soils (20 cm); *Stereocaulon tomentosum* (eyed foam lichen); *Sheperdia canadensis* (soapberry)

Site Name and Location: BJ019 (6250722, 444536)
Samples Collected: *Vaccinium membranaceum* (black huckleberry); *Vaccinium ovalifolium* (oval leaf blueberry)

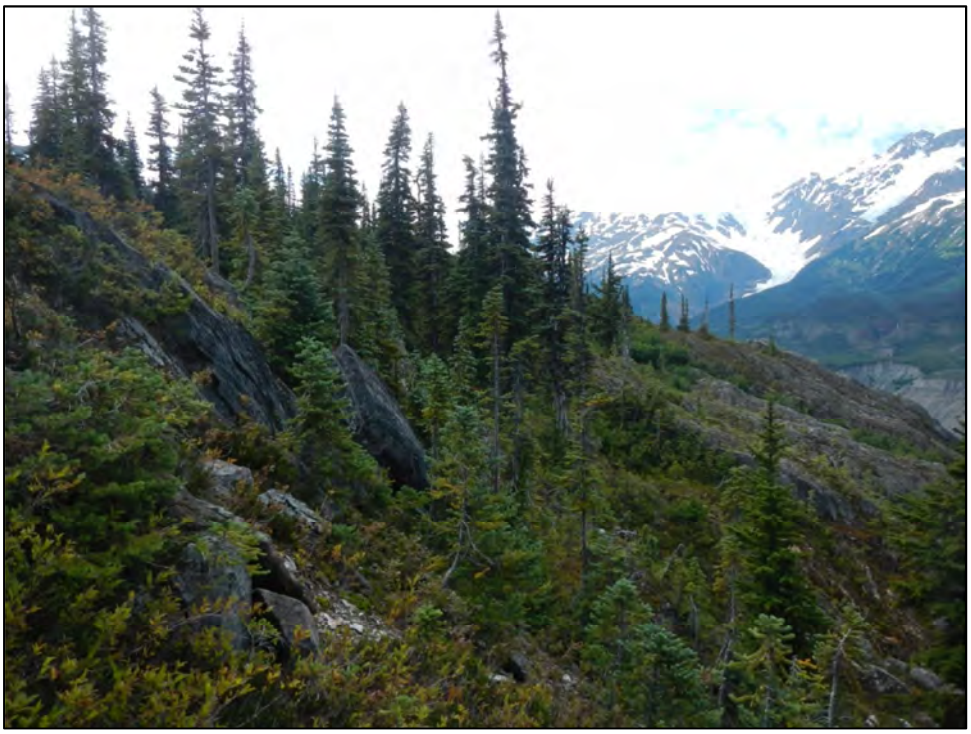
Site Name and Location: BJ020 (6249718, 447285)
Samples Collected: *Vaccinium membranaceum* (black huckleberry)

Site Name and Location: BJ021 (6263617, 461900)
Samples Collected: Soils (20 cm)

Site Name and Location: BJ022 (6263540, 459334)
Samples Collected: Soils (20 cm and 60 cm)

Site Name and Location: BJ024 (6263537, 457423)
Samples Collected: *Cladina stygia* (black footed reindeer lichen); *Vaccinium ovalifolium* (oval leaf blueberry)

Site Name and Location: BJ025 (6263576, 457297)
Samples Collected: Soils (20 cm and 60 cm)

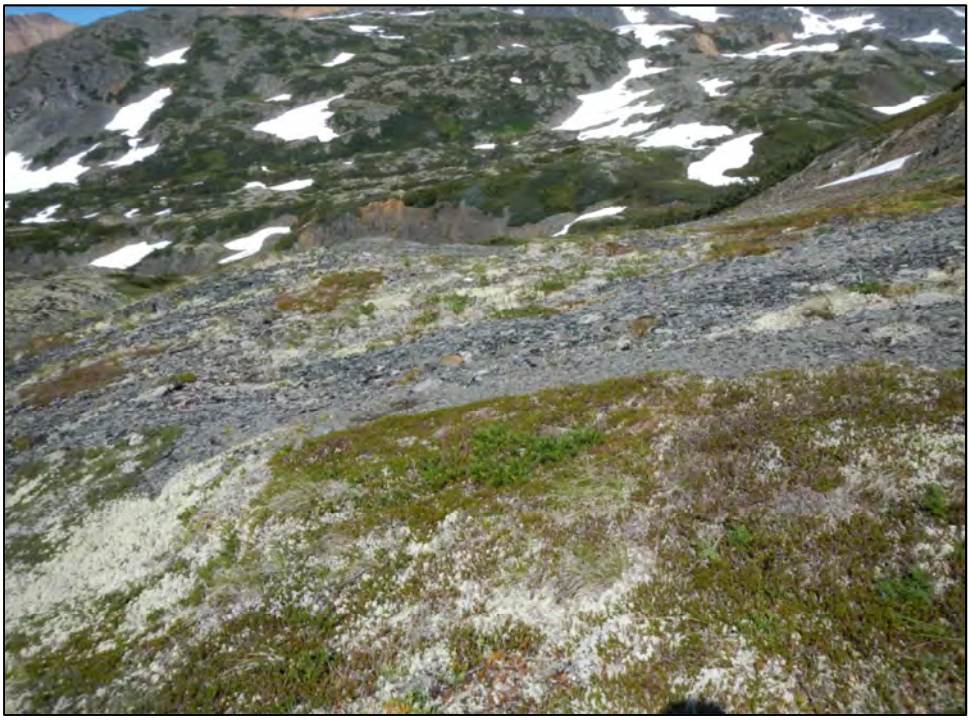


Site Name and Location: BJ028 (6243464, 434572)
Samples Collected: *Stereocaulon tomentosum* (eyed foam lichen) and *Vaccinium membranaceum* (black huckleberry)

Site Name and Location: BJ029 (6247319, 434566)
Samples Collected: *Vaccinium ovalifolium* (oval leaf blueberry)

Site Name and Location: BJ030 (6250502, 437021)
Samples Collected: Soils (20 cm and 60 cm); *Stereocaulon tomentosum* (eyed foam lichen); *Sheperdia canadensis* (soapberry), *Vaccinium membranaceum* (black huckleberry)

Site Name and Location: BJ031 (625196, 438196)
Samples Collected: Soils (20 cm)



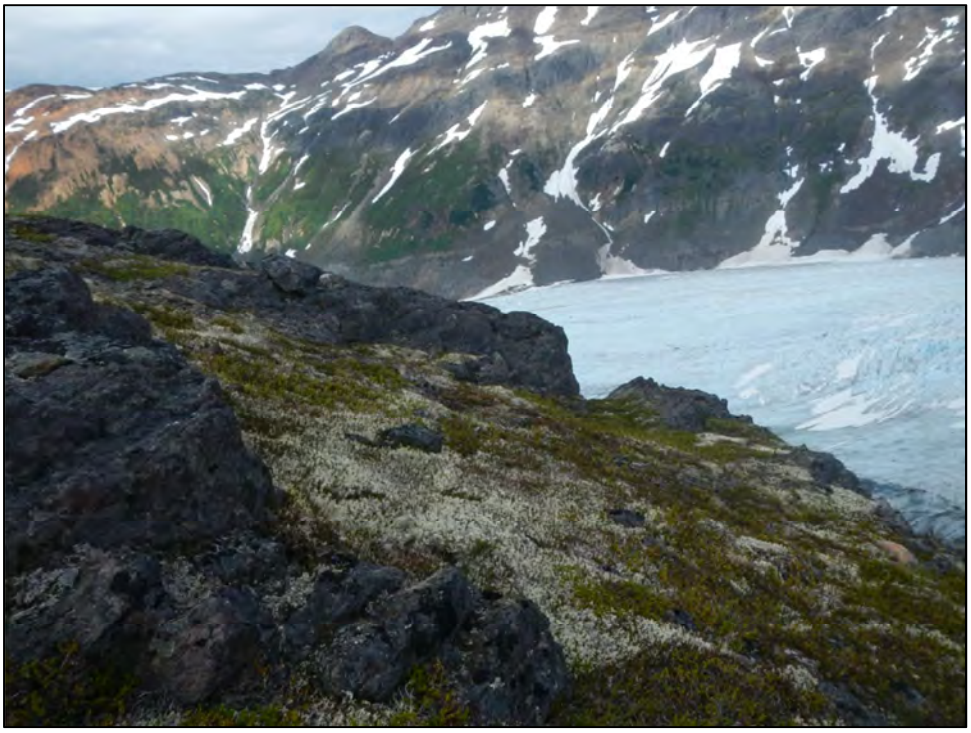
Site Name and Location: V030 (6258785, 425201)
Samples Collected: Soils (20 cm and 60 cm); *Cladina stygia* (black footed reindeer lichen)

Site Name and Location: Soil 1 (6260382, 468344)
Samples Collected: Soils (20 cm); *Viburnum edule* (highbush cranberry); *Vaccinium membranaceum* (black huckleberry)

Site Name and Location: Soil 2 (6259805, 467215)
Samples Collected: Soils (20 cm); *Vaccinium ovalifolium* (oval leaf blueberry); *Vaccinium membranaceum* (black huckleberry)

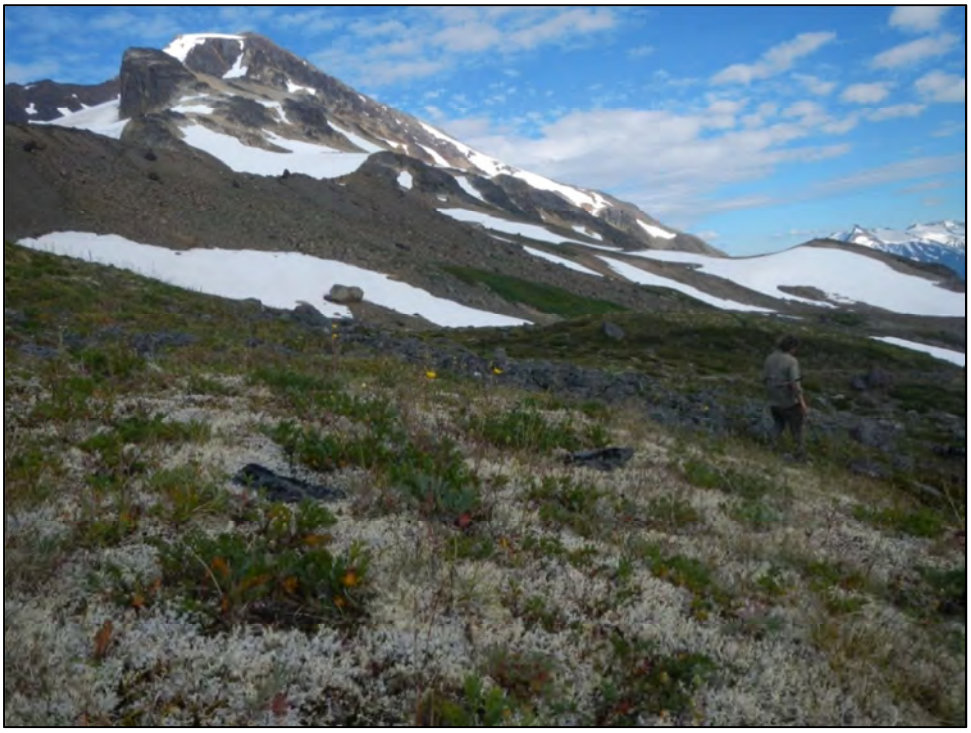
Site Name and Location: Soil 3 (6262278, 468826)
Samples Collected: Soils (20 cm); *Vaccinium ovalifolium* (oval leaf blueberry)*; Vaccinium membranaceum* (black huckleberry)

Site Name and Location: Soil 4 (6262865, 469503)
Samples Collected: Soils (20 cm); *Vaccinium ovalifolium* (oval leaf blueberry)*; Vaccinium membranaceum* (black huckleberry)

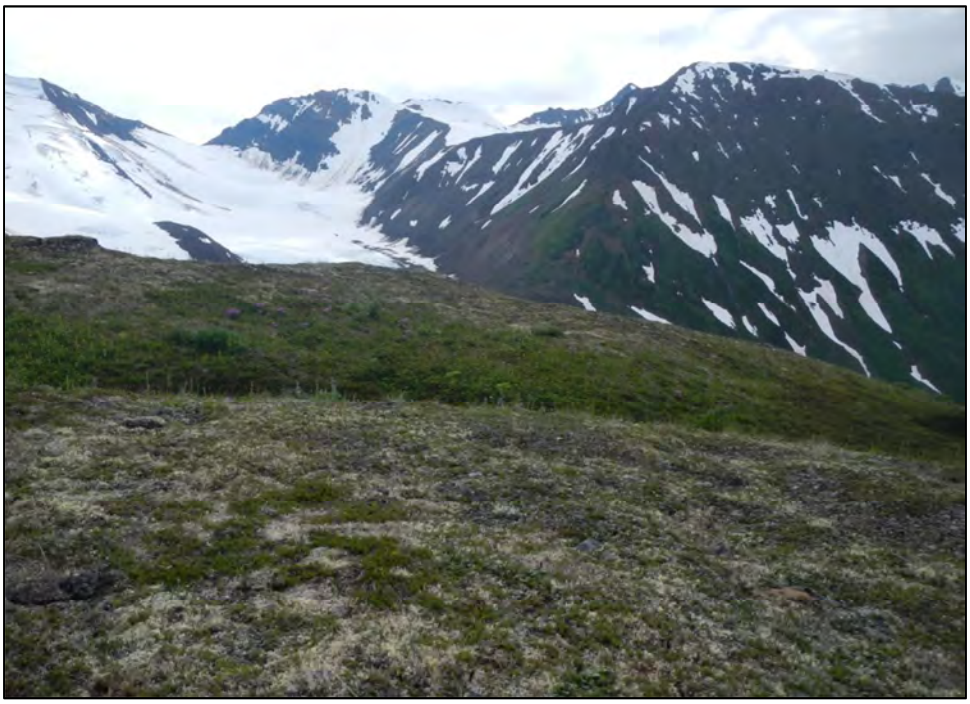


Site Name and Location: BJ Ref North 1 (6265181, 425747)
Samples Collected: Soils (20 cm); *Cladina stygia* (black footed reindeer lichen)

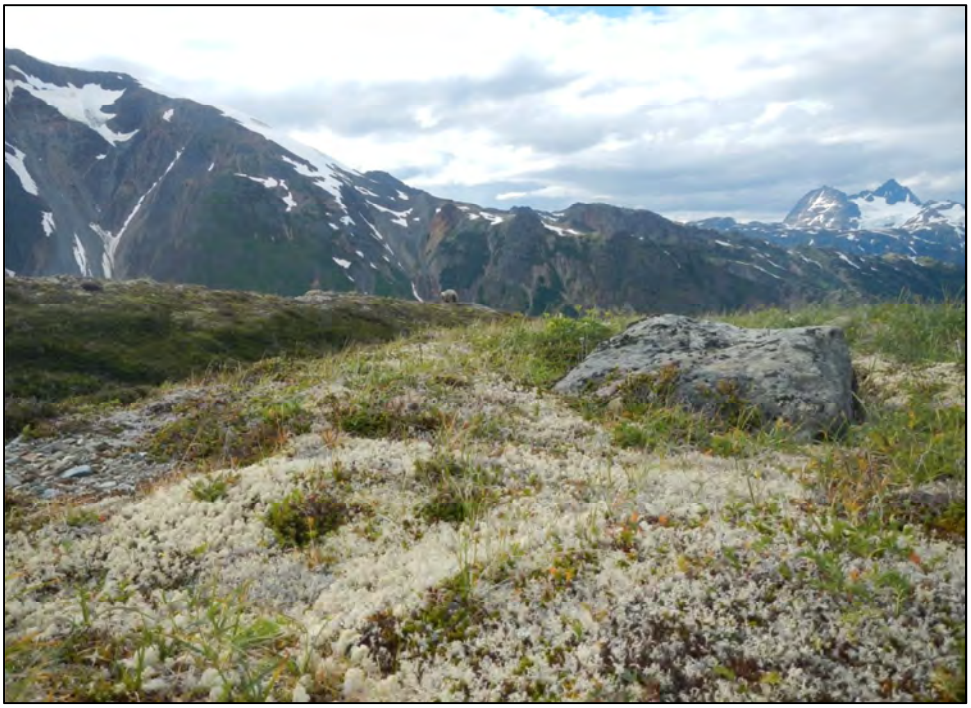
Site Name and Location: BJ Ref East 1(6255710, 438494)
Samples Collected: Soils (20 cm); *Cladina stygia* (black footed reindeer lichen); *Vaccinium uliginosum* (bog blueberry)



Site Name and Location: BJ Ref East 2 (6254887, 441895)
Samples Collected: Soils (20 cm); *Cladina stygia* (black footed reindeer lichen)



Site Name and Location: BJ Ref North 2 (6276600, 424991)
Samples Collected: Soils (20 cm and 60 cm); *Cladina stygia* (black footed reindeer lichen)



Site Name and Location: BJ Ref West (6256805, 417103)
Samples Collected: Soils (20cm); *Cladina stygia* (black footed reindeer lichen)

Site Name and Location: BJ Ref South (6245378, 430298)
Samples Collected: Soils (20cm); *Cladina stygia* (black footed reindeer lichen); *Vaccinium uliginosum* (bog blueberry)

Site Name and Location: W005 (6260624, 452059)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W009 (6262682, 452931)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W012 (6260673, 467665)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W023 (6253678, 453833)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W025 (6258420, 468828)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W037 (6264375, 451453)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W047 (6263193, 45719)
Samples Collected: *Carex aquatilis* (water sedge)

NO PHOTO AVAILABLE

Site Name and Location: W055 (6264618, 465858)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W058 (6255470, 452356)
Samples Collected: *Carex aquatilis* (water sedge)

Site Name and Location: W060 (6259907, 453137)
Samples Collected: *Carex aquatilis* (water sedge)

Appendix 2
Soil Sample Results, 2012

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RESCAN ENVIRONMENTAL SERVICES
ATTN: Daniel McAllister
Sixth Floor
1111 West Hastings Street
Vancouver BC V6E 2J3

Date Received: 23-NOV-12
Report Date: 04-DEC-12 14:16 (MT)
Version: FINAL

Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1241433

Project P.O. #: NOT SUBMITTED
Job Reference: 1042-008-02-89
C of C Numbers:
Legal Site Desc:

Amber Springer
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-1 soil 15-AUG-12 12-7103-20CM	L1241433-2 soil 15-AUG-12 12-7103-60CM	L1241433-3 soil 14-AUG-12 BJ014-20CM	L1241433-4 soil 14-AUG-12 BJ014-60CM	L1241433-5 soil 15-AUG-12 12-1705-20CM
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	5.63	5.89	4.77	4.93	7.56
Metals	Aluminum (Al) (mg/kg)	12200	10300	37900	9300	25200
	Antimony (Sb) (mg/kg)	2.65	2.18	1.43	6.45	17.0
	Arsenic (As) (mg/kg)	24.5	19.4	19.3	203	380
	Barium (Ba) (mg/kg)	87.7	73.6	58.0	78.0	118
	Beryllium (Be) (mg/kg)	0.23	0.28	1.57	1.14	0.34
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	0.24	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.132	0.146	0.244	0.539	0.275
	Calcium (Ca) (mg/kg)	2330	3190	550	663	30100
	Chromium (Cr) (mg/kg)	2.18	2.37	2.93	1.88	6.47
	Cobalt (Co) (mg/kg)	9.47	7.92	1.85	15.1	17.1
	Copper (Cu) (mg/kg)	9.78	14.0	11.4	29.6	34.6
	Iron (Fe) (mg/kg)	29500	24200	41200	56200	51300
	Lead (Pb) (mg/kg)	10.5	8.64	22.5	67.2	8.20
	Lithium (Li) (mg/kg)	16.8	17.4	5.3	<5.0	61.4
	Magnesium (Mg) (mg/kg)	5490	5020	363	1020	15900
	Manganese (Mn) (mg/kg)	1100	1040	679	1960	1550
	Mercury (Hg) (mg/kg)	0.0383	0.0474	0.0918	0.0743	0.772 DLM
	Molybdenum (Mo) (mg/kg)	1.58	0.91	4.66	1.34	5.91
	Nickel (Ni) (mg/kg)	2.69	2.59	1.49	4.50	7.05
	Phosphorus (P) (mg/kg)	526	980	615	888	1590
	Potassium (K) (mg/kg)	660	610	1090	580	270
	Selenium (Se) (mg/kg)	<0.20	0.21	0.81	0.37	1.22
	Silver (Ag) (mg/kg)	<0.10	<0.10	2.09	0.89	<0.10
	Sodium (Na) (mg/kg)	<100	<100	1380	<100	<100
	Strontium (Sr) (mg/kg)	20.7	19.1	2.05	5.28	31.8
	Thallium (Tl) (mg/kg)	0.136	0.098	0.176	1.20	1.25
	Tin (Sn) (mg/kg)	<2.0	<2.0	6.8	<2.0	<2.0
	Titanium (Ti) (mg/kg)	962	712	701	32.9	346
	Uranium (U) (mg/kg)	0.813	0.773	2.69	1.02	0.395
	Vanadium (V) (mg/kg)	51.3	37.3	5.85	24.2	121
	Zinc (Zn) (mg/kg)	49.8	46.2	78.9	113	80.2

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1241433-6	L1241433-7	L1241433-8	L1241433-9	L1241433-10
	Description	soil	soil	soil	soil	soil
	Sampled Date	15-AUG-12	19-AUG-12	19-AUG-12	15-AUG-12	19-AUG-12
	Sampled Time					
	Client ID	12-1705-60CM	12-7169-20CM	12-7166-20CM	BJ015-20CM	BJ031-20CM
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	8.08	4.72	4.18	5.27	4.84
Metals	Aluminum (Al) (mg/kg)	26600	16000	22300	19200	12300
	Antimony (Sb) (mg/kg)	21.1	2.00	0.64	2.59	0.95
	Arsenic (As) (mg/kg)	384	20.1	12.4	41.4	10.6
	Barium (Ba) (mg/kg)	230	79.2	130	112	48.3
	Beryllium (Be) (mg/kg)	0.39	0.31	0.48	0.47	0.32
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	0.23	<0.20
	Cadmium (Cd) (mg/kg)	0.251	0.245	0.797	0.128	1.15
	Calcium (Ca) (mg/kg)	46100	4780	406	1520	6740
	Chromium (Cr) (mg/kg)	8.04	31.6	57.6	24.9	25.6
	Cobalt (Co) (mg/kg)	19.3	11.8	13.2	13.2	10.8
	Copper (Cu) (mg/kg)	39.7	27.7	30.2	30.6	25.9
	Iron (Fe) (mg/kg)	53200	38300	34100	42900	29000
	Lead (Pb) (mg/kg)	9.33	11.5	9.61	14.9	7.82
	Lithium (Li) (mg/kg)	61.5	19.6	26.2	26.5	19.1
	Magnesium (Mg) (mg/kg)	16600	10100	5160	7540	8320
	Manganese (Mn) (mg/kg)	1590	548	523	987	687
	Mercury (Hg) (mg/kg)	0.967 DLM	0.0557	0.0965	0.0732	0.0441
	Molybdenum (Mo) (mg/kg)	6.21	1.83	1.40	1.74	2.00
	Nickel (Ni) (mg/kg)	7.74	28.0	47.0	30.6	32.4
	Phosphorus (P) (mg/kg)	1530	1090	1200	858	1020
	Potassium (K) (mg/kg)	300	720	1210	750	630
	Selenium (Se) (mg/kg)	1.35	0.95	0.89	0.91	0.94
	Silver (Ag) (mg/kg)	0.10	0.31	1.02	0.18	0.22
	Sodium (Na) (mg/kg)	120	120	<100	<100	<100
	Strontium (Sr) (mg/kg)	50.1	24.7	6.63	16.0	39.5
	Thallium (Tl) (mg/kg)	1.42	0.086	0.313	0.195	0.143
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	405	882	66.9	295	377
	Uranium (U) (mg/kg)	0.459	0.407	0.286	0.591	0.307
	Vanadium (V) (mg/kg)	131	63.8	64.7	44.8	41.1
	Zinc (Zn) (mg/kg)	80.6	74.4	79.3	74.4	126

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-11 soil 17-AUG-12 BJ022-20CM	L1241433-12 soil 17-AUG-12 BJ022-60CM	L1241433-13 soil 17-AUG-12 BJ021-20CM	L1241433-14 soil 14-AUG-12 12-7137-20CM (BJ013)	L1241433-15 soil 14-AUG-12 12-7137-60CM (BJ013)
Sample ID / Description / Sampled Date / Sampled Time / Client ID						
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	4.81	4.80	4.62	4.96	4.30
Metals	Aluminum (Al) (mg/kg)	20900	19100	29100	18200	3220
	Antimony (Sb) (mg/kg)	0.53	0.48	0.52	5.03	47.8
	Arsenic (As) (mg/kg)	9.14	7.86	11.3	493	312
	Barium (Ba) (mg/kg)	67.0	54.7	81.9	76.2	119
	Beryllium (Be) (mg/kg)	0.37	0.38	0.44	0.59	<0.20
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	0.21	0.27
	Cadmium (Cd) (mg/kg)	0.391	0.273	0.221	0.113	0.091
	Calcium (Ca) (mg/kg)	434	526	254	771	256
	Chromium (Cr) (mg/kg)	64.7	60.8	85.3	8.71	2.07
	Cobalt (Co) (mg/kg)	10.6	9.18	13.8	9.26	1.07
	Copper (Cu) (mg/kg)	31.2	29.3	31.7	19.0	32.6
	Iron (Fe) (mg/kg)	33700	31500	48900	44000	47100
	Lead (Pb) (mg/kg)	7.12	5.60	8.36	36.2	83.5
	Lithium (Li) (mg/kg)	26.7	30.7	33.2	24.9	<5.0
	Magnesium (Mg) (mg/kg)	10500	10500	8680	5220	887
	Manganese (Mn) (mg/kg)	510	419	986	1020	142
	Mercury (Hg) (mg/kg)	0.0677	0.0737	0.105	0.0691	0.0757
	Molybdenum (Mo) (mg/kg)	1.48	1.16	1.72	1.99	6.49
	Nickel (Ni) (mg/kg)	69.0	72.1	57.6	7.48	1.22
	Phosphorus (P) (mg/kg)	476	419	903	679	1120
	Potassium (K) (mg/kg)	570	540	1060	790	1170
	Selenium (Se) (mg/kg)	0.51	0.65	1.07	0.66	2.47
	Silver (Ag) (mg/kg)	0.82	1.15	0.83	1.16	27.8
	Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
	Strontium (Sr) (mg/kg)	5.88	5.37	3.76	7.42	17.5
	Thallium (Tl) (mg/kg)	0.100	0.072	0.176	0.222	0.383
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	79.0	114	79.3	218	107
	Uranium (U) (mg/kg)	0.253	0.240	0.309	1.30	0.199
	Vanadium (V) (mg/kg)	50.7	44.8	75.9	30.3	13.2
	Zinc (Zn) (mg/kg)	80.8	74.9	82.4	80.3	31.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-16 soil 19-AUG-12 12-7168-20CM	L1241433-17 soil 19-AUG-12 12-7167-20CM	L1241433-18 soil 19-AUG-12 12-7167-40CM	L1241433-19 soil 17-AUG-12 BJ025-20CM	L1241433-20 soil 17-AUG-12 BJ025-60CM
Sample ID / Description / Sampled Date / Sampled Time / Client ID						
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	5.68	4.90	4.86	3.82	4.30
Metals	Aluminum (Al) (mg/kg)	17000	26100	26300	15500	28700
	Antimony (Sb) (mg/kg)	3.21	0.90	0.83	0.61	0.59
	Arsenic (As) (mg/kg)	75.7	14.7	13.9	7.96	9.06
	Barium (Ba) (mg/kg)	111	83.2	74.6	47.9	50.0
	Beryllium (Be) (mg/kg)	0.42	0.30	0.35	<0.20	0.32
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.147	0.297	0.272	0.099	0.171
	Calcium (Ca) (mg/kg)	4880	1450	1440	202	262
	Chromium (Cr) (mg/kg)	8.67	69.0	65.9	68.9	96.0
	Cobalt (Co) (mg/kg)	12.6	20.6	18.4	4.81	12.7
	Copper (Cu) (mg/kg)	22.8	30.3	33.4	17.9	37.9
	Iron (Fe) (mg/kg)	39800	50400	50300	34000	48700
	Lead (Pb) (mg/kg)	13.9	10.7	9.52	9.03	10.7
	Lithium (Li) (mg/kg)	13.7	35.1	33.7	9.4	41.4
	Magnesium (Mg) (mg/kg)	7000	8880	9740	3860	9890
	Manganese (Mn) (mg/kg)	787	1710	1660	532	887
	Mercury (Hg) (mg/kg)	0.0509	0.0506	0.0555	0.0489	0.0758
	Molybdenum (Mo) (mg/kg)	1.20	1.88	1.88	1.53	1.81
	Nickel (Ni) (mg/kg)	6.56	59.4	63.8	33.1	73.4
	Phosphorus (P) (mg/kg)	695	798	835	956	1110
	Potassium (K) (mg/kg)	550	920	720	540	600
	Selenium (Se) (mg/kg)	0.33	0.74	0.79	0.51	0.80
	Silver (Ag) (mg/kg)	0.36	0.57	0.56	0.84	0.44
	Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
	Strontium (Sr) (mg/kg)	38.7	15.7	14.9	3.50	3.42
	Thallium (Tl) (mg/kg)	0.204	0.173	0.153	0.136	0.109
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	1670	253	189	46.1	51.2
	Uranium (U) (mg/kg)	0.820	0.252	0.247	0.108	0.224
	Vanadium (V) (mg/kg)	94.0	83.5	80.6	75.2	62.8
	Zinc (Zn) (mg/kg)	54.4	135	110	38.7	81.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-21 soil 17-AUG-12 12-7108-20CM	L1241433-22 soil 17-AUG-12 12-7162-20CM	L1241433-23 soil 16-AUG-12 BJ018-20CM	L1241433-24 soil 19-AUG-12 12-7168-20CM	L1241433-25 soil 19-AUG-12 12-7168-60CM
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	5.06	3.82	4.86	4.03	4.36
Metals	Aluminum (Al) (mg/kg)	26600	23000	16400	26400	25200
	Antimony (Sb) (mg/kg)	0.52	0.52	1.97	0.32	0.35
	Arsenic (As) (mg/kg)	8.25	10.9	21.1	5.28	8.20
	Barium (Ba) (mg/kg)	84.5	64.1	115	43.3	48.1
	Beryllium (Be) (mg/kg)	0.55	<0.20	0.34	0.31	0.26
	Bismuth (Bi) (mg/kg)	<0.20	0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.610	0.098	0.296	0.260	0.138
	Calcium (Ca) (mg/kg)	790	182	4470	579	259
	Chromium (Cr) (mg/kg)	60.5	67.3	30.5	69.1	81.9
	Cobalt (Co) (mg/kg)	10.3	6.05	13.1	2.10	3.64
	Copper (Cu) (mg/kg)	54.7	17.1	28.5	130	107
	Iron (Fe) (mg/kg)	36800	38700	39500	28600	32400
	Lead (Pb) (mg/kg)	7.69	8.82	10.9	9.82	7.28
	Lithium (Li) (mg/kg)	25.0	11.2	19.0	<5.0	22.8
	Magnesium (Mg) (mg/kg)	7710	5560	9790	1390	4570
	Manganese (Mn) (mg/kg)	612	544	666	84.2	123
	Mercury (Hg) (mg/kg)	0.130	0.0381	0.0956	0.399	0.170
	Molybdenum (Mo) (mg/kg)	3.96	1.32	1.71	1.39	1.63
	Nickel (Ni) (mg/kg)	54.2	36.1	26.3	23.7	36.0
	Phosphorus (P) (mg/kg)	1200	1760	1120	3120	1420
	Potassium (K) (mg/kg)	910	1110	570	400	650
	Selenium (Se) (mg/kg)	1.00	0.43	1.17	2.21	1.78
	Silver (Ag) (mg/kg)	1.12	0.14	0.42	3.39	0.99
	Sodium (Na) (mg/kg)	<100	<100	110	<100	<100
	Strontium (Sr) (mg/kg)	13.0	2.42	22.9	12.0	5.15
	Thallium (Tl) (mg/kg)	0.141	0.204	0.089	0.069	0.128
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	105	127	953	96.6	60.3
	Uranium (U) (mg/kg)	0.687	0.123	0.585	0.821	0.564
	Vanadium (V) (mg/kg)	48.7	110	67.7	24.6	48.3
	Zinc (Zn) (mg/kg)	71.6	53.2	74.5	13.7	30.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-26 soil 18-AUG-12 BJ REF EAST 1-20CM	L1241433-27 soil 19-AUG-12 BJ REF SOUTH-20CM	L1241433-28 soil 20-AUG-12 BJ CAMP 4-20CM	L1241433-29 soil 20-AUG-12 BJ CAMP 1-20CM	L1241433-30 soil 20-AUG-12 BJ CAMP 2-20CM
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	4.18	5.04	4.82	4.98	4.53
Metals	Aluminum (Al) (mg/kg)	21600	23200	17100	14200	9790
	Antimony (Sb) (mg/kg)	0.58	6.95	2.41	3.38	9.81
	Arsenic (As) (mg/kg)	6.75	54.2	28.1	87.3	883
	Barium (Ba) (mg/kg)	46.5	98.7	77.1	107	106
	Beryllium (Be) (mg/kg)	0.63	0.62	0.39	0.56	0.31
	Bismuth (Bi) (mg/kg)	0.24	<0.20	<0.20	0.29	<0.20
	Cadmium (Cd) (mg/kg)	0.130	0.379	0.107	0.078	0.105
	Calcium (Ca) (mg/kg)	1070	2080	3960	477	660
	Chromium (Cr) (mg/kg)	10.5	22.7	5.17	7.52	3.64
	Cobalt (Co) (mg/kg)	2.92	19.3	11.0	6.12	9.53
	Copper (Cu) (mg/kg)	8.84	72.8	23.4	23.4	17.7
	Iron (Fe) (mg/kg)	35200	42500	36500	47700	35900
	Lead (Pb) (mg/kg)	14.7	25.3	8.97	20.5	18.3
	Lithium (Li) (mg/kg)	6.7	23.2	18.8	14.8	11.2
	Magnesium (Mg) (mg/kg)	2400	10300	8110	5010	2600
	Manganese (Mn) (mg/kg)	387	989	582	567	1070
	Mercury (Hg) (mg/kg)	0.0392	0.0443	0.0759	0.0810	0.0661
	Molybdenum (Mo) (mg/kg)	2.68	1.90	0.85	2.68	1.49
	Nickel (Ni) (mg/kg)	7.30	26.6	4.83	6.14	3.53
	Phosphorus (P) (mg/kg)	511	816	569	1190	666
	Potassium (K) (mg/kg)	590	890	570	790	1040
	Selenium (Se) (mg/kg)	0.39	0.75	0.53	1.78	0.47
	Silver (Ag) (mg/kg)	0.23	0.16	0.36	0.44	1.31
	Sodium (Na) (mg/kg)	240	<100	<100	110	<100
	Strontium (Sr) (mg/kg)	11.4	12.7	33.2	7.27	8.48
	Thallium (Tl) (mg/kg)	0.084	0.158	0.125	0.165	0.345
	Tin (Sn) (mg/kg)	4.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	1460	369	1620	382	154
	Uranium (U) (mg/kg)	1.25	0.339	1.30	0.629	0.400
	Vanadium (V) (mg/kg)	61.2	77.8	78.1	29.8	24.5
	Zinc (Zn) (mg/kg)	55.3	102	56.1	67.6	43.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1241433-31	L1241433-32	L1241433-33	L1241433-34	L1241433-35
Description	soil	soil	soil	soil	soil
Sampled Date	15-AUG-12	18-AUG-12	18-AUG-12	14-AUG-12	14-AUG-12
Sampled Time					
Client ID	BJ015-60CM	BJ REF NORTH 2-20CM	BJ REF NORTH 2-60CM	V030-20CM	V030-60CM
Grouping **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	5.33	5.29	5.23	5.06	5.69
Metals Aluminum (Al) (mg/kg)	18000	18000	24200	19400	19300
Antimony (Sb) (mg/kg)	2.54	1.39	1.46	1.96	2.06
Arsenic (As) (mg/kg)	47.0	23.3	26.9	17.9	18.5
Barium (Ba) (mg/kg)	118	296	252	48.6	75.9
Beryllium (Be) (mg/kg)	0.42	1.06	1.76	0.30	0.26
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.181	0.189	0.160	0.227	0.193
Calcium (Ca) (mg/kg)	2370	5350	2020	1910	1870
Chromium (Cr) (mg/kg)	20.4	17.7	21.0	17.4	17.5
Cobalt (Co) (mg/kg)	17.2	14.2	15.7	14.4	13.2
Copper (Cu) (mg/kg)	37.2	59.7	72.2	26.4	27.0
Iron (Fe) (mg/kg)	38800	43100	48400	37400	37300
Lead (Pb) (mg/kg)	13.4	15.9	19.1	10.1	11.1
Lithium (Li) (mg/kg)	24.8	16.6	21.4	27.6	23.7
Magnesium (Mg) (mg/kg)	7080	4130	4420	9540	7990
Manganese (Mn) (mg/kg)	1460	1150	1440	970	1090
Mercury (Hg) (mg/kg)	0.137	0.0797	0.182	0.0197	0.0305
Molybdenum (Mo) (mg/kg)	1.30	1.42	1.73	1.24	1.89
Nickel (Ni) (mg/kg)	30.6	20.9	24.6	10.9	9.34
Phosphorus (P) (mg/kg)	996	1570	1370	991	689
Potassium (K) (mg/kg)	880	1270	1290	310	380
Selenium (Se) (mg/kg)	0.95	1.16	1.91	0.42	0.57
Silver (Ag) (mg/kg)	0.31	0.14	0.14	<0.10	<0.10
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	18.4	42.6	17.7	6.69	10.1
Thallium (Tl) (mg/kg)	0.143	0.193	0.282	0.081	0.116
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	284	105	63.5	219	339
Uranium (U) (mg/kg)	0.587	0.499	0.882	0.114	0.195
Vanadium (V) (mg/kg)	40.0	70.4	73.4	41.7	49.6
Zinc (Zn) (mg/kg)	82.7	106	126	61.9	58.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1241433-36	L1241433-37	L1241433-38	L1241433-39	L1241433-40
Description	soil	soil	soil	soil	soil
Sampled Date	19-AUG-12	18-AUG-12	18-AUG-12	18-AUG-12	18-AUG-12
Sampled Time					
Client ID	BJ REF WEST-20CM	BJ REF EAST 2-20CM	BJ REF NORTH 1-20CM	BJ030-20CM	BJ030-60CM
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	4.82	4.58	4.74	6.44	6.60
Metals Aluminum (Al) (mg/kg)	26400	12800	20400	16900	16700
Antimony (Sb) (mg/kg)	1.62	3.61	1.78	1.17	1.49
Arsenic (As) (mg/kg)	11.5	25.7	67.7	13.4	14.2
Barium (Ba) (mg/kg)	71.8	101	56.5	46.2	52.2
Beryllium (Be) (mg/kg)	0.48	0.32	0.39	0.35	0.38
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.211	0.216	0.120	0.562	0.655
Calcium (Ca) (mg/kg)	2200	724	1770	3940	4650
Chromium (Cr) (mg/kg)	24.2	4.25	4.39	34.3	34.4
Cobalt (Co) (mg/kg)	13.1	16.0	11.4	14.5	14.3
Copper (Cu) (mg/kg)	58.8	10.9	15.9	39.3	39.8
Iron (Fe) (mg/kg)	46900	41400	44800	38200	37200
Lead (Pb) (mg/kg)	13.9	12.2	10.5	9.70	9.86
Lithium (Li) (mg/kg)	8.4	9.6	17.1	24.0	23.3
Magnesium (Mg) (mg/kg)	11400	5450	4800	11500	10700
Manganese (Mn) (mg/kg)	782	2570	987	727	815
Mercury (Hg) (mg/kg)	0.0356	0.0271	0.0971	0.0446	0.0581
Molybdenum (Mo) (mg/kg)	2.75	1.04	1.95	1.95	1.94
Nickel (Ni) (mg/kg)	14.4	2.91	2.76	41.4	40.3
Phosphorus (P) (mg/kg)	842	810	702	970	1130
Potassium (K) (mg/kg)	980	1350	310	280	390
Selenium (Se) (mg/kg)	0.99	<0.20	0.48	0.60	0.61
Silver (Ag) (mg/kg)	0.23	<0.10	<0.10	0.22	0.23
Sodium (Na) (mg/kg)	<100	<100	110	<100	<100
Strontium (Sr) (mg/kg)	22.3	5.62	16.5	16.1	25.1
Thallium (Tl) (mg/kg)	0.134	0.214	0.097	0.100	0.119
Tin (Sn) (mg/kg)	<2.0	<2.0	2.1	<2.0	<2.0
Titanium (Ti) (mg/kg)	1590	507	918	351	485
Uranium (U) (mg/kg)	0.576	0.601	0.841	0.335	0.442
Vanadium (V) (mg/kg)	149	55.4	43.2	57.0	59.3
Zinc (Zn) (mg/kg)	82.6	82.3	68.6	113	114

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-41 soil 20-AUG-12 SOIL 4-20CM	L1241433-42 soil 20-AUG-12 SOIL 1-20CM	L1241433-43 soil 20-AUG-12 SOIL 3-20CM	L1241433-44 soil 20-AUG-12 SOIL 2-20CM	L1241433-45 soil 20-AUG-12 LEACH SITE 3-20CM
Sample ID / Description / Sampled Date / Sampled Time / Client ID						
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	4.34	4.08	3.82	4.61	4.22
Metals	Aluminum (Al) (mg/kg)	25900	21100	10100	17100	16700
	Antimony (Sb) (mg/kg)	0.53	0.55	0.47	0.56	0.17
	Arsenic (As) (mg/kg)	8.85	9.74	9.52	8.52	5.50
	Barium (Ba) (mg/kg)	95.1	132	74.7	132	102
	Beryllium (Be) (mg/kg)	0.26	0.22	<0.20	0.21	<0.20
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.216	0.101	0.125	0.301	0.116
	Calcium (Ca) (mg/kg)	595	556	535	2010	564
	Chromium (Cr) (mg/kg)	72.4	48.3	34.7	62.8	51.0
	Cobalt (Co) (mg/kg)	10.1	10.1	5.45	6.02	4.27
	Copper (Cu) (mg/kg)	22.9	15.6	18.6	26.1	10.0
	Iron (Fe) (mg/kg)	44600	29300	22500	28500	19500
	Lead (Pb) (mg/kg)	7.13	8.32	6.54	7.73	4.17
	Lithium (Li) (mg/kg)	21.4	12.3	<5.0	14.5	16.6
	Magnesium (Mg) (mg/kg)	6720	4840	2480	6530	5760
	Manganese (Mn) (mg/kg)	865	1910	407	1470	256
	Mercury (Hg) (mg/kg)	0.102	0.0440	0.0553	0.0845	0.0360
	Molybdenum (Mo) (mg/kg)	0.92	1.28	1.21	1.29	0.88
	Nickel (Ni) (mg/kg)	43.4	28.5	23.0	47.7	36.4
	Phosphorus (P) (mg/kg)	463	1230	1170	932	398
	Potassium (K) (mg/kg)	530	870	730	1030	760
	Selenium (Se) (mg/kg)	0.52	0.35	0.36	0.36	<0.20
	Silver (Ag) (mg/kg)	0.41	0.22	<0.10	0.47	0.32
	Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
	Strontium (Sr) (mg/kg)	5.80	5.61	5.56	10.7	7.84
	Thallium (Tl) (mg/kg)	0.085	0.249	0.143	0.149	0.093
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	376	185	150	51.8	89.9
	Uranium (U) (mg/kg)	0.215	0.102	0.107	0.105	0.083
	Vanadium (V) (mg/kg)	86.6	83.1	74.0	64.3	66.2
	Zinc (Zn) (mg/kg)	64.9	61.1	38.2	76.2	47.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1241433-46 soil 20-AUG-12 LEACH SITE 1-20CM	L1241433-47 soil 20-AUG-12 LEACH SITE 2-20CM	L1241433-48 soil DUP1	L1241433-49 soil DUP2	L1241433-50 soil DUP3
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	4.65	4.08	5.07	7.35	4.56
Metals	Aluminum (Al) (mg/kg)	25500	12700	18400	25100	12400
	Antimony (Sb) (mg/kg)	0.62	<0.10	4.16	16.4	4.70
	Arsenic (As) (mg/kg)	11.2	2.12	513	332	21.0
	Barium (Ba) (mg/kg)	107	70.0	79.7	116	121
	Beryllium (Be) (mg/kg)	0.33	<0.20	0.61	0.34	0.29
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.265	0.138	0.128	0.263	0.223
	Calcium (Ca) (mg/kg)	690	292	774	30400	597
	Chromium (Cr) (mg/kg)	65.8	30.9	7.83	6.42	4.42
	Cobalt (Co) (mg/kg)	11.0	2.90	9.22	16.0	16.5
	Copper (Cu) (mg/kg)	24.5	5.47	16.1	33.0	13.2
	Iron (Fe) (mg/kg)	40700	10300	42300	46100	43200
	Lead (Pb) (mg/kg)	7.53	3.13	28.7	7.48	14.4
	Lithium (Li) (mg/kg)	41.6	10.9	25.2	56.5	9.7
	Magnesium (Mg) (mg/kg)	8000	2960	4970	15500	5330
	Manganese (Mn) (mg/kg)	1220	148	1140	1400	2590
	Mercury (Hg) (mg/kg)	0.0596	0.0229	0.0605	0.647	0.0298
	Molybdenum (Mo) (mg/kg)	1.42	<0.50	2.09	5.61	1.28
	Nickel (Ni) (mg/kg)	54.5	17.1	5.99	6.64	3.16
	Phosphorus (P) (mg/kg)	1030	274	767	1360	910
	Potassium (K) (mg/kg)	680	430	790	320	1320
	Selenium (Se) (mg/kg)	0.55	<0.20	0.59	1.43	<0.20
	Silver (Ag) (mg/kg)	0.45	0.19	0.35	<0.10	0.10
	Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
	Strontium (Sr) (mg/kg)	5.69	3.30	7.12	34.0	5.01
	Thallium (Tl) (mg/kg)	0.161	0.116	0.225	1.19	0.216
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	59.8	75.1	234	494	392
	Uranium (U) (mg/kg)	0.103	0.069	1.32	0.429	0.642
	Vanadium (V) (mg/kg)	76.4	38.9	31.1	124	56.5
	Zinc (Zn) (mg/kg)	146	29.7	82.9	79.6	85.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
NR:NR	No Result: Sample Not Received At Laboratory - Samples # BJ Camp3-20cm, BJ 013-20cm, BJ013-60cm, BJ018-20cm - not received

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted For Sample Matrix Effects

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1241433-COFC

1

Chain of Custody / Analytical Request F
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Report to:	**Daniel McAllister**	**Report Format / Distribution**	
Company:	Rescan Environmental Services		
Contact:	**Daniel McAllister**		
Address:	1111 West Hastings Street	Email 1:	dmcallister@rescan.com
	Vancouver BC V6 E 2J3	Email 2:	nbush@rescan.com
Phone:	604 689 9460		
Invoice To: same as report		Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:		**Client / Project Information:**	
Contact:		Job #:	1042-008-02-89
Address:		PO/AFE:	
Sample		Legal Site Description:	
Phone:		Quote #:	

Lab Work Order # (lab use only)

ALS Contact: Amber Springer

Sampler (Initials):

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm
1	12-7103-20cm	15-Aug-12	
2	12-7103-60cm	15-Aug-12	
3	BJ014-20cm	14-Aug-12	
4	BJ014-60cm	14-Aug-12	
5	12-7105-20cm	15-Aug-12	
6	12-7105-60cm	15-Aug-12	
7	12-7169-20cm	19-Aug-12	
8	12-7166-20cm	19-Aug-12	
9	BJ015-20cm	15-Aug-12	
10	BJ031-20cm	19-Aug-12	
11	BJ022-20cm	17-Aug-12	
12	BJ022-60cm	17-Aug-12	
13	BJ021-20cm	17-Aug-12	
14	12-7137-20cm (BJ013)	14-Aug-12	
15	12-7137-60cm (BJ013)	14-Aug-12	
16	12-7168-20cm	19-Aug-12	
17	12-7167-20cm	19-Aug-12	
18	12-7167-40cm	19-Aug-12	
19	BJ025-20cm	17-Aug-12	
20	BJ025-60cm	17-Aug-12	
21	12-7108-20cm	17-Aug-12	
22	12-7162-20cm	17-Aug-12	
23	BJ018-20cm	16-Aug-12	

24	12-7168-20cm	19-Aug-12	
25	12-7168-60cm	19-Aug-12	

Guidelines / Regulations	Special Instructions / Hazardous Detai
Some samples may contain elevated levels of arsenic.	

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adj

Relinquished By:	T Gradowski	July 16th, 2012	Received By:		Date & Time:
Relinquished By:			Received By:		Date & Time:

L1241433-COFC

L1241433-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # 1042-

Pag

Report to:	**Daniel McAllister**	**Report Format / Distribution**	**Service Request**
Company:	Rescan Environmental Services		x Regular Serv
Contact:	**Daniel McAllister**		Rush Service
Address:	1111 West Hastings Street	Email 1: dmcallister@rescan.com	Priority Servi
	Vancouver BC V6 E 2J3	Email 2: nbush@rescan.com	Emergency S
Phone:	604 689 9460		A
Invoice To:	**same as report**	Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:		**Client / Project Information:**	
Contact:		Job #: 1042-008-02-89	
Address:		PO/AFE:	
Sample		Legal Site Description:	
Phone:		Quote #:	
Lab Work Order # (lab use only)		**ALS Contact:** Amber Springer	**Sampler** (Initials): DM

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type	CCME metals
26	BJ REF EAST 1-20cm	8/18/2012		soil	X
27	BJ REF SOUTH-20cm	8/19/2012		soil	X
23	BJ CAMP 3-20cm	8/20/2012		soil	X
28	BJ CAMP 4-20cm	20-Aug-12		soil	X
29	BJ CAMP 1-20cm	20-Aug-12		soil	X
30	BJ CAMP 2-20cm	20-Aug-12		soil	X
31	BJ01S-60cm	15-Aug-12		soil	X
33	BJ013-20cm	8/14/2012		soil	X
34	BJ013-60cm	8/14/2012		soil	X
32	BJ REF NORTH 2-20cm	8/18/2012		soil	X
35	BJ REF NORTH 2-60cm	8/18/2012		soil	X
24	V030-20cm	14-Aug-12		soil	X
25	V030-60cm	14-Aug-12		soil	X
36	BJ REF WEST-20cm	8/19/2012		soil	X
37	BJ REF EAST 2-20cm	18-Aug-12		soil	X
38	BJ REF NORTH 1-20cm	8/18/2012		soil	X
39	BJ030-20cm	18-Aug-12		soil	X
40	BJ030-60cm	18-Aug-12		soil	X
44	BJ018-20cm	8/16/2012		soil	X
41	SOIL 4-20cm	20-Aug-12		soil	X
42	SOIL 1-20cm	20-Aug-12		soil	X
43	SOIL 3-20cm	20-Aug-12		soil	X
44	SOIL 2-20cm	20-Aug-12		soil	X
45	LEACH SITE 3-20cm	20-Aug-12		soil	X
46	LEACH SITE 1-20cm	20-Aug-12		soil	X
47	LEACH SITE 2-20cm	20-Aug-12		soil	X

Guidelines / Regulations

Some samples may contain elevated levels of arsenic.

Special Instructions / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:	T Gradowski	July 16th, 2012	Received By:		Date & Time:		Samp Temperature
Relinquished By:			Received By:		Date & Time:		

L1241433-COFC

4

Chain of Custody / Analytical Request F
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Report to:	**Daniel McAllister**	**Report Format / Distribution**	
Company:	Rescan Environmental Services		
Contact:	**Daniel McAllister**		
Address:	1111 West Hastings Street	Email 1:	dmcallister@rescan.com
	Vancouver BC V6 E 2J3	Email 2:	nbush@rescan.com
Phone:	604 689 9460		
Invoice To: same as report		Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:		**Client / Project Information:**	
Contact:		Job #:	1042-008-02-89
Address:		PO/AFE:	
Sample		Legal Site Description:	
Phone:		Quote #:	
Lab Work Order # (lab use only)		**ALS Contact:**	Amber Springer
		Sampler (Initials):	

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm
48	Dup1	not applicable	
49	Dup2	not applicable	
50	Dup3	not applicable	

Appendix 3

Lichen Tissue Results for *Cladina stygia* and *Stereocaulon tomentosum* Samples, 2012

Rescan™
Engineers and Scientists

RESCAN ENVIRONMENTAL SERVICES
ATTN: Natasha Bush
Sixth Floor
1111 West Hastings Street
Vancouver BC V6E 2J3

Date Received: 01-NOV-12
Report Date: 10-DEC-12 13:41 (MT)
Version: FINAL REV. 3

Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1232285

Project P.O. #: NOT SUBMITTED
Job Reference: 1042-008-03-89
C of C Numbers: 1, 2, 3
Legal Site Desc:

Amber Springer
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1232285-1 tissue 18-AUG-12 BJ REF EAST 1 CLADINA STYGIA	L1232285-2 tissue 19-AUG-12 BJ REF SOUTH CLADINA STYGIA	L1232285-3 tissue 20-AUG-12 BJ CAMP 3 CLADINA STYGIA	L1232285-4 tissue 20-AUG-12 BJ CAMP 4 CLADINA STYGIA	L1232285-5 tissue 20-AUG-12 BJ CAMP 1 CLADINA STYGIA
TISSUE						
Physical Tests	% Moisture (%)	7.69	7.84	8.47	7.79	7.57
Metals	Aluminum (Al)-Total (mg/kg)	475	273	186	290	395
	Aluminum (Al)-Total (mg/kg wwt)	439	251	170	267	365
	Antimony (Sb)-Total (mg/kg)	0.024	0.069	0.060	0.062	0.056
	Antimony (Sb)-Total (mg/kg wwt)	0.0217	0.0634	0.0552	0.0568	0.0521
	Arsenic (As)-Total (mg/kg)	0.232	0.486	0.817	0.703	0.583
	Arsenic (As)-Total (mg/kg wwt)	0.214	0.448	0.747	0.648	0.539
	Barium (Ba)-Total (mg/kg)	19.4	28.0	10.7	37.4	40.0
	Barium (Ba)-Total (mg/kg wwt)	17.9	25.8	9.83	34.5	37.0
	Beryllium (Be)-Total (mg/kg)	0.020	0.010	<0.010	<0.010	0.016
	Beryllium (Be)-Total (mg/kg wwt)	0.0181	0.0092	0.0057	0.0088	0.0152
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	0.011
	Bismuth (Bi)-Total (mg/kg wwt)	0.0033	0.0079	0.0064	0.0061	0.0101
	Boron (B)-Total (mg/kg)	2.2	1.3	1.8	3.5	1.5
	Boron (B)-Total (mg/kg wwt)	2.03	1.23	1.61	3.23	1.42
	Cadmium (Cd)-Total (mg/kg)	0.028	0.036	0.024	0.032	0.043
	Cadmium (Cd)-Total (mg/kg wwt)	0.0256	0.0329	0.0216	0.0294	0.0400
	Calcium (Ca)-Total (mg/kg)	834	1500	2890	1530	1870
	Calcium (Ca)-Total (mg/kg wwt)	770	1380	2640	1410	1730
	Cesium (Cs)-Total (mg/kg)	0.0611	0.157	0.0803	0.0899	2.23
	Cesium (Cs)-Total (mg/kg wwt)	0.0564	0.145	0.0735	0.0829	2.07
	Chromium (Cr)-Total (mg/kg)	0.231	0.355	0.339	0.278	0.281
	Chromium (Cr)-Total (mg/kg wwt)	0.214	0.327	0.310	0.257	0.259
	Cobalt (Co)-Total (mg/kg)	0.112	0.191	0.122	0.237	0.161
	Cobalt (Co)-Total (mg/kg wwt)	0.104	0.176	0.112	0.219	0.149
	Copper (Cu)-Total (mg/kg)	1.50	1.97	1.29	1.80	1.81
	Copper (Cu)-Total (mg/kg wwt)	1.38	1.82	1.18	1.66	1.67
	Gallium (Ga)-Total (mg/kg)	0.064	0.073	0.050	0.079	0.102
	Gallium (Ga)-Total (mg/kg wwt)	0.0588	0.0669	0.0460	0.0730	0.0943
	Iron (Fe)-Total (mg/kg)	277	441	281	396	364
	Iron (Fe)-Total (mg/kg wwt)	255	407	257	365	337
	Lead (Pb)-Total (mg/kg)	0.395	1.06	0.572	0.557	0.825
	Lead (Pb)-Total (mg/kg wwt)	0.364	0.977	0.523	0.514	0.762
	Lithium (Li)-Total (mg/kg)	0.12	<0.10	<0.10	<0.10	0.29
	Lithium (Li)-Total (mg/kg wwt)	0.106	0.083	0.066	0.068	0.264
	Magnesium (Mg)-Total (mg/kg)	186	228	203	299	355
	Magnesium (Mg)-Total (mg/kg wwt)	172	210	186	275	328

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1232285-6	L1232285-7	L1232285-8	L1232285-9	L1232285-10
Description	tissue	tissue	tissue	tissue	tissue
Sampled Date	20-AUG-12	15-AUG-12	15-AUG-12	14-AUG-12	14-AUG-12
Sampled Time					
Client ID	BJ CAMP 2 CLADINA STYGIA	12-7139 CLADINA STYGIA	BJ015 CLADINA STYGIA	12-7137 CLADINA STYGIA	BJ013 CLADINA STYGIA
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	7.16	7.84	7.68	7.38	6.76
Metals Aluminum (Al)-Total (mg/kg)	782	292	270	255	175
Aluminum (Al)-Total (mg/kg wwt)	726	269	250	236	163
Antimony (Sb)-Total (mg/kg)	0.099	0.091	0.069	0.379	0.069
Antimony (Sb)-Total (mg/kg wwt)	0.0922	0.0835	0.0633	0.351	0.0641
Arsenic (As)-Total (mg/kg)	7.88	4.53	0.684	2.40	1.45
Arsenic (As)-Total (mg/kg wwt)	7.31	4.17	0.631	2.22	1.36
Barium (Ba)-Total (mg/kg)	31.6	26.8	14.3	10.3	9.46
Barium (Ba)-Total (mg/kg wwt)	29.3	24.7	13.2	9.51	8.82
Beryllium (Be)-Total (mg/kg)	0.019	0.012	0.011	0.019	<0.010
Beryllium (Be)-Total (mg/kg wwt)	0.0178	0.0111	0.0097	0.0177	0.0067
Bismuth (Bi)-Total (mg/kg)	0.012	<0.010	<0.010	0.019	<0.010
Bismuth (Bi)-Total (mg/kg wwt)	0.0111	0.0076	0.0081	0.0171	0.0084
Boron (B)-Total (mg/kg)	1.9	2.0	<2.0 DLB	2.1	1.4
Boron (B)-Total (mg/kg wwt)	1.74	1.80	<1.0 DLB	1.93	1.28
Cadmium (Cd)-Total (mg/kg)	0.026	0.098	0.022	0.117	0.040
Cadmium (Cd)-Total (mg/kg wwt)	0.0244	0.0904	0.0201	0.109	0.0377
Calcium (Ca)-Total (mg/kg)	1850	1930	935	1050	1690
Calcium (Ca)-Total (mg/kg wwt)	1710	1780	864	971	1570
Cesium (Cs)-Total (mg/kg)	0.349	0.566	0.113	0.215	0.0879
Cesium (Cs)-Total (mg/kg wwt)	0.324	0.522	0.105	0.199	0.0820
Chromium (Cr)-Total (mg/kg)	0.439	0.265	0.256	0.248	0.177
Chromium (Cr)-Total (mg/kg wwt)	0.407	0.244	0.236	0.229	0.165
Cobalt (Co)-Total (mg/kg)	0.275	0.187	0.184	0.162	0.137
Cobalt (Co)-Total (mg/kg wwt)	0.255	0.173	0.170	0.150	0.127
Copper (Cu)-Total (mg/kg)	1.88	1.96	1.46	1.81	1.42
Copper (Cu)-Total (mg/kg wwt)	1.74	1.81	1.35	1.68	1.32
Gallium (Ga)-Total (mg/kg)	0.227	0.081	0.074	0.073	0.051
Gallium (Ga)-Total (mg/kg wwt)	0.210	0.0742	0.0681	0.0679	0.0479
Iron (Fe)-Total (mg/kg)	1210	438	389	607	286
Iron (Fe)-Total (mg/kg wwt)	1120	404	359	562	266
Lead (Pb)-Total (mg/kg)	1.43	0.751	1.08	3.33	0.821
Lead (Pb)-Total (mg/kg wwt)	1.33	0.692	1.00	3.08	0.765
Lithium (Li)-Total (mg/kg)	0.46	0.19	<0.10	<0.10	<0.10
Lithium (Li)-Total (mg/kg wwt)	0.426	0.171	0.086	0.075	0.060
Magnesium (Mg)-Total (mg/kg)	335	288	185	181	212
Magnesium (Mg)-Total (mg/kg wwt)	311	265	171	168	198

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-11	L1232285-12	L1232285-13	L1232285-14	L1232285-15
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	14-AUG-12	19-AUG-12	17-AUG-12	19-AUG-12
	Sampled Time					
	Client ID	BJ REF NORTH 2 CLADINA STYGIA	V030 CLADINA STYGIA	BJ REF WEST CLADINA STYGIA	BJ024 CLADINA STYGIA	BJ REF EAST 2 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	7.81	7.78	7.39	8.35	7.56
Metals	Aluminum (Al)-Total (mg/kg)	190	390	473	177	268
	Aluminum (Al)-Total (mg/kg wwt)	175	360	438	162	248
	Antimony (Sb)-Total (mg/kg)	0.034	0.095	0.068	<0.010	0.031
	Antimony (Sb)-Total (mg/kg wwt)	0.0312	0.0879	0.0631	0.0079	0.0289
	Arsenic (As)-Total (mg/kg)	0.305	1.53	0.488	0.083	0.233
	Arsenic (As)-Total (mg/kg wwt)	0.281	1.41	0.452	0.0756	0.215
	Barium (Ba)-Total (mg/kg)	14.0	10.3	11.6	26.9	10.8
	Barium (Ba)-Total (mg/kg wwt)	12.9	9.52	10.7	24.7	9.99
	Beryllium (Be)-Total (mg/kg)	<0.010	0.015	0.015	0.033	0.011
	Beryllium (Be)-Total (mg/kg wwt)	0.0078	0.0138	0.0140	0.0306	0.0099
	Bismuth (Bi)-Total (mg/kg)	<0.010	0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg wwt)	0.0038	0.0092	0.0083	0.0051	0.0038
	Boron (B)-Total (mg/kg)	<2.0 DLB	1.5	1.4	<1.0	<1.0
	Boron (B)-Total (mg/kg wwt)	<1.1 DLB	1.42	1.26	<0.70 DLB	<0.70 DLB
	Cadmium (Cd)-Total (mg/kg)	0.116	0.044	0.035	0.010	0.031
	Cadmium (Cd)-Total (mg/kg wwt)	0.107	0.0402	0.0326	0.0096	0.0290
	Calcium (Ca)-Total (mg/kg)	997	857	360	366	284
	Calcium (Ca)-Total (mg/kg wwt)	919	791	333	336	263
	Cesium (Cs)-Total (mg/kg)	0.0447	0.0914	0.0446	0.386	0.103
	Cesium (Cs)-Total (mg/kg wwt)	0.0412	0.0843	0.0413	0.353	0.0956
	Chromium (Cr)-Total (mg/kg)	0.283	0.376	0.519	0.181	0.162
	Chromium (Cr)-Total (mg/kg wwt)	0.261	0.347	0.481	0.165	0.150
	Cobalt (Co)-Total (mg/kg)	0.169	0.301	0.337	0.509	0.116
	Cobalt (Co)-Total (mg/kg wwt)	0.156	0.278	0.312	0.466	0.108
	Copper (Cu)-Total (mg/kg)	1.33	2.43	1.90	1.04	0.598
	Copper (Cu)-Total (mg/kg wwt)	1.22	2.24	1.76	0.950	0.553
	Gallium (Ga)-Total (mg/kg)	0.062	0.118	0.150	0.028	0.077
	Gallium (Ga)-Total (mg/kg wwt)	0.0573	0.109	0.139	0.0256	0.0716
	Iron (Fe)-Total (mg/kg)	259	618	654	101	473
	Iron (Fe)-Total (mg/kg wwt)	239	570	605	92.1	437
	Lead (Pb)-Total (mg/kg)	0.427	0.934	0.709	0.271	0.432
	Lead (Pb)-Total (mg/kg wwt)	0.394	0.861	0.657	0.248	0.399
	Lithium (Li)-Total (mg/kg)	<0.10	0.20	0.12	<0.10	<0.10
	Lithium (Li)-Total (mg/kg wwt)	0.065	0.188	0.109	0.026	0.046
	Magnesium (Mg)-Total (mg/kg)	251	316	285	280	133
	Magnesium (Mg)-Total (mg/kg wwt)	232	292	263	256	123

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-16	L1232285-17	L1232285-18	L1232285-19	L1232285-20
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	18-AUG-12	18-AUG-12	16-AUG-12	14-AUG-12
	Sampled Time					
	Client ID	BJ REF NORTH 1 CLADINA STYGIA	BJ030 STER. SP.	BJ028 STER. SP.	BJ018 STER. SP.	DUP1 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	7.71	9.40	7.19	6.95	7.54
Metals	Aluminum (Al)-Total (mg/kg)	201	281	793	147	320
	Aluminum (Al)-Total (mg/kg wwt)	186	254	736	137	295
	Antimony (Sb)-Total (mg/kg)	0.037	0.031	0.034	0.018	0.100
	Antimony (Sb)-Total (mg/kg wwt)	0.0345	0.0279	0.0317	0.0168	0.0920
	Arsenic (As)-Total (mg/kg)	0.442	0.385	0.458	0.277	3.43
	Arsenic (As)-Total (mg/kg wwt)	0.408	0.349	0.425	0.258	3.17
	Barium (Ba)-Total (mg/kg)	14.0	13.8	21.6	6.52	62.0
	Barium (Ba)-Total (mg/kg wwt)	12.9	12.5	20.1	6.06	57.3
	Beryllium (Be)-Total (mg/kg)	0.011	0.019	0.037	<0.010	0.010
	Beryllium (Be)-Total (mg/kg wwt)	0.0100	0.0172	0.0345	0.0055	0.0094
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg wwt)	0.0089	0.0044	0.0051	0.0056	0.0092
	Boron (B)-Total (mg/kg)	1.6	<1.0 DLB	1.9	1.6	3.3
	Boron (B)-Total (mg/kg wwt)	1.48	<0.60	1.72	1.49	3.01
	Cadmium (Cd)-Total (mg/kg)	<0.010	0.116	0.071	0.094	0.046
	Cadmium (Cd)-Total (mg/kg wwt)	0.0066	0.105	0.0654	0.0874	0.0422
	Calcium (Ca)-Total (mg/kg)	542	559	2750	3910	2130
	Calcium (Ca)-Total (mg/kg wwt)	500	506	2550	3640	1970
	Cesium (Cs)-Total (mg/kg)	0.968	0.282	0.121	0.0928	0.144
	Cesium (Cs)-Total (mg/kg wwt)	0.894	0.256	0.112	0.0864	0.133
	Chromium (Cr)-Total (mg/kg)	0.211	0.398	0.415	0.255	0.271
	Chromium (Cr)-Total (mg/kg wwt)	0.195	0.360	0.385	0.237	0.251
	Cobalt (Co)-Total (mg/kg)	0.096	0.214	0.318	0.145	0.213
	Cobalt (Co)-Total (mg/kg wwt)	0.0886	0.193	0.295	0.135	0.197
	Copper (Cu)-Total (mg/kg)	1.53	3.38	6.09	2.19	2.34
	Copper (Cu)-Total (mg/kg wwt)	1.41	3.06	5.65	2.04	2.17
	Gallium (Ga)-Total (mg/kg)	0.054	0.062	0.080	0.042	0.108
	Gallium (Ga)-Total (mg/kg wwt)	0.0502	0.0557	0.0746	0.0391	0.100
	Iron (Fe)-Total (mg/kg)	288	381	496	230	599
	Iron (Fe)-Total (mg/kg wwt)	266	345	460	214	554
	Lead (Pb)-Total (mg/kg)	0.550	0.392	0.522	0.450	0.963
	Lead (Pb)-Total (mg/kg wwt)	0.507	0.355	0.485	0.419	0.890
	Lithium (Li)-Total (mg/kg)	<0.10	0.17	0.14	<0.10	0.16
	Lithium (Li)-Total (mg/kg wwt)	0.066	0.153	0.131	0.070	0.149
	Magnesium (Mg)-Total (mg/kg)	151	247	323	228	402
	Magnesium (Mg)-Total (mg/kg wwt)	140	223	300	212	371

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-21	L1232285-22			
	Description	tissue	tissue			
	Sampled Date	18-AUG-12	14-AUG-12			
	Sampled Time					
	Client ID	DUP2 CLADINA STYGIA	DUP3 CLADINA STYGIA			
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	7.29	7.58			
Metals	Aluminum (Al)-Total (mg/kg)	159	243			
	Aluminum (Al)-Total (mg/kg wwt)	147	225			
	Antimony (Sb)-Total (mg/kg)	0.047	0.036			
	Antimony (Sb)-Total (mg/kg wwt)	0.0435	0.0331			
	Arsenic (As)-Total (mg/kg)	0.597	0.380			
	Arsenic (As)-Total (mg/kg wwt)	0.554	0.351			
	Barium (Ba)-Total (mg/kg)	7.29	17.4			
	Barium (Ba)-Total (mg/kg wwt)	6.76	16.1			
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010			
	Beryllium (Be)-Total (mg/kg wwt)	0.0046	0.0086			
	Bismuth (Bi)-Total (mg/kg)	<0.010	<0.010			
	Bismuth (Bi)-Total (mg/kg wwt)	0.0058	0.0062			
	Boron (B)-Total (mg/kg)	1.8	1.7			
	Boron (B)-Total (mg/kg wwt)	1.66	1.55			
	Cadmium (Cd)-Total (mg/kg)	0.022	0.053			
	Cadmium (Cd)-Total (mg/kg wwt)	0.0202	0.0486			
	Calcium (Ca)-Total (mg/kg)	1330	466			
	Calcium (Ca)-Total (mg/kg wwt)	1240	431			
	Cesium (Cs)-Total (mg/kg)	0.0624	0.0558			
	Cesium (Cs)-Total (mg/kg wwt)	0.0579	0.0515			
	Chromium (Cr)-Total (mg/kg)	0.248	0.219			
	Chromium (Cr)-Total (mg/kg wwt)	0.230	0.202			
	Cobalt (Co)-Total (mg/kg)	0.133	0.150			
	Cobalt (Co)-Total (mg/kg wwt)	0.124	0.139			
	Copper (Cu)-Total (mg/kg)	2.29	1.10			
	Copper (Cu)-Total (mg/kg wwt)	2.12	1.01			
	Gallium (Ga)-Total (mg/kg)	0.054	0.060			
	Gallium (Ga)-Total (mg/kg wwt)	0.0504	0.0555			
	Iron (Fe)-Total (mg/kg)	288	299			
	Iron (Fe)-Total (mg/kg wwt)	267	276			
	Lead (Pb)-Total (mg/kg)	0.539	0.757			
	Lead (Pb)-Total (mg/kg wwt)	0.500	0.700			
	Lithium (Li)-Total (mg/kg)	<0.10	<0.10			
	Lithium (Li)-Total (mg/kg wwt)	0.034	0.063			
	Magnesium (Mg)-Total (mg/kg)	170	190			
	Magnesium (Mg)-Total (mg/kg wwt)	158	176			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-1	L1232285-2	L1232285-3	L1232285-4	L1232285-5
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	19-AUG-12	20-AUG-12	20-AUG-12	20-AUG-12
	Sampled Time					
	Client ID	BJ REF EAST 1 CLADINA STYGIA	BJ REF SOUTH CLADINA STYGIA	BJ CAMP 3 CLADINA STYGIA	BJ CAMP 4 CLADINA STYGIA	BJ CAMP 1 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Manganese (Mn)-Total (mg/kg)	23.4	124	62.5	191	95.5
	Manganese (Mn)-Total (mg/kg wwt)	21.6	115	57.2	177	88.3
	Mercury (Hg)-Total (mg/kg)	0.0307	0.0573	0.0303	0.0618	0.0378
	Mercury (Hg)-Total (mg/kg wwt)	0.0283	0.0528	0.0278	0.0570	0.0350
	Molybdenum (Mo)-Total (mg/kg)	0.062	0.087	0.064	0.055	0.068
	Molybdenum (Mo)-Total (mg/kg wwt)	0.0575	0.0803	0.0585	0.0506	0.0629
	Nickel (Ni)-Total (mg/kg)	0.719	1.02	0.862	0.644	1.31
	Nickel (Ni)-Total (mg/kg wwt)	0.663	0.944	0.789	0.594	1.21
	Phosphorus (P)-Total (mg/kg)	346	463	269	371	356
	Phosphorus (P)-Total (mg/kg wwt)	319	426	246	342	329
	Potassium (K)-Total (mg/kg)	1280	830	550	630	770
	Potassium (K)-Total (mg/kg wwt)	1180	764	506	584	711
	Rhenium (Re)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Rhenium (Re)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Rubidium (Rb)-Total (mg/kg)	5.28	2.35	1.06	1.58	1.86
	Rubidium (Rb)-Total (mg/kg wwt)	4.87	2.17	0.973	1.46	1.72
	Selenium (Se)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Selenium (Se)-Total (mg/kg wwt)	0.057	0.040	0.035	0.034	0.033
	Sodium (Na)-Total (mg/kg)	<200 DLM	<200 DLM	<200 DLM	<200 DLM	<200 DLM
	Sodium (Na)-Total (mg/kg wwt)	<40 DLM	<40 DLM	<40 DLM	<40 DLM	<40 DLM
	Strontium (Sr)-Total (mg/kg)	3.74	2.06	3.05	5.71	3.10
	Strontium (Sr)-Total (mg/kg wwt)	3.45	1.90	2.79	5.27	2.86
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg)	0.0030	0.0138	0.0055	0.0070	0.0099
	Thallium (Tl)-Total (mg/kg wwt)	0.00279	0.0128	0.00502	0.00648	0.00916
	Thorium (Th)-Total (mg/kg)	0.017	0.017	0.018	0.024	0.034
	Thorium (Th)-Total (mg/kg wwt)	0.0159	0.0157	0.0167	0.0224	0.0319
	Tin (Sn)-Total (mg/kg)	0.020	0.023	0.020	0.059	0.022
	Tin (Sn)-Total (mg/kg wwt)	0.0187	0.0216	0.0185	0.0543	0.0204
	Titanium (Ti)-Total (mg/kg)	20.1	11.4	13.7	17.8	21.5
	Titanium (Ti)-Total (mg/kg wwt)	18.6	10.5	12.5	16.4	19.9
	Uranium (U)-Total (mg/kg)	0.0067	0.0073	0.0068	0.0105	0.0176
	Uranium (U)-Total (mg/kg wwt)	0.00615	0.00670	0.00626	0.00971	0.0163
	Vanadium (V)-Total (mg/kg)	0.615	0.978	0.771	0.914	0.836
	Vanadium (V)-Total (mg/kg wwt)	0.567	0.902	0.706	0.843	0.773
	Yttrium (Y)-Total (mg/kg)	0.190	0.118	0.103	0.121	0.207

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-6	L1232285-7	L1232285-8	L1232285-9	L1232285-10
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	20-AUG-12	15-AUG-12	15-AUG-12	14-AUG-12	14-AUG-12
	Sampled Time					
	Client ID	BJ CAMP 2 CLADINA STYGIA	12-7139 CLADINA STYGIA	BJ015 CLADINA STYGIA	12-7137 CLADINA STYGIA	BJ013 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Manganese (Mn)-Total (mg/kg)	122	132	64.5	73.7	31.6
	Manganese (Mn)-Total (mg/kg wwt)	113	122	59.6	68.3	29.4
	Mercury (Hg)-Total (mg/kg)	0.0351	0.0502	0.0410	0.0674	0.0480
	Mercury (Hg)-Total (mg/kg wwt)	0.0326	0.0462	0.0378	0.0625	0.0448
	Molybdenum (Mo)-Total (mg/kg)	0.113	0.081	0.072	0.141	0.047
	Molybdenum (Mo)-Total (mg/kg wwt)	0.105	0.0744	0.0665	0.130	0.0436
	Nickel (Ni)-Total (mg/kg)	0.993	1.03	0.972	0.619	0.900
	Nickel (Ni)-Total (mg/kg wwt)	0.922	0.951	0.898	0.573	0.839
	Phosphorus (P)-Total (mg/kg)	377	362	182	342	333
	Phosphorus (P)-Total (mg/kg wwt)	350	333	168	317	310
	Potassium (K)-Total (mg/kg)	960	830	500	880	1030
	Potassium (K)-Total (mg/kg wwt)	890	769	460	819	958
	Rhenium (Re)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Rhenium (Re)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Rubidium (Rb)-Total (mg/kg)	3.00	2.05	1.47	2.03	0.923
	Rubidium (Rb)-Total (mg/kg wwt)	2.78	1.89	1.35	1.88	0.860
	Selenium (Se)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Selenium (Se)-Total (mg/kg wwt)	0.050	0.042	0.039	0.073	0.036
	Sodium (Na)-Total (mg/kg)	<200 DLM	<200 DLM	<200 DLM	<200 DLM	<200 DLM
	Sodium (Na)-Total (mg/kg wwt)	<40 DLM	<40 DLM	<40 DLM	<40 DLM	<40 DLM
	Strontium (Sr)-Total (mg/kg)	3.99	4.09	2.94	3.42	6.09
	Strontium (Sr)-Total (mg/kg wwt)	3.70	3.77	2.71	3.16	5.68
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Tellurium (Te)-Total (mg/kg wwt)	0.0069	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg)	0.0270	0.0094	0.0066	0.0138	0.0059
	Thallium (Tl)-Total (mg/kg wwt)	0.0250	0.00870	0.00607	0.0128	0.00546
	Thorium (Th)-Total (mg/kg)	0.071	0.025	0.024	0.040	0.022
	Thorium (Th)-Total (mg/kg wwt)	0.0658	0.0228	0.0225	0.0373	0.0203
	Tin (Sn)-Total (mg/kg)	0.026	0.023	0.025	0.040	0.024
	Tin (Sn)-Total (mg/kg wwt)	0.0238	0.0214	0.0227	0.0369	0.0227
	Titanium (Ti)-Total (mg/kg)	29.8	15.4	10.8	9.69	6.31
	Titanium (Ti)-Total (mg/kg wwt)	27.7	14.2	9.95	8.98	5.88
	Uranium (U)-Total (mg/kg)	0.0235	0.0110	0.0096	0.0113	0.0099
	Uranium (U)-Total (mg/kg wwt)	0.0218	0.0101	0.00883	0.0105	0.00919
	Vanadium (V)-Total (mg/kg)	1.79	0.973	0.633	0.757	0.521
	Vanadium (V)-Total (mg/kg wwt)	1.66	0.896	0.584	0.701	0.486
	Yttrium (Y)-Total (mg/kg)	0.223	0.234	0.133	0.137	0.124

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1232285-11	L1232285-12	L1232285-13	L1232285-14	L1232285-15
Description	tissue	tissue	tissue	tissue	tissue
Sampled Date	18-AUG-12	14-AUG-12	19-AUG-12	17-AUG-12	19-AUG-12
Sampled Time					
Client ID	BJ REF NORTH 2 CLADINA STYGIA	V030 CLADINA STYGIA	BJ REF WEST CLADINA STYGIA	BJ024 CLADINA STYGIA	BJ REF EAST 2 CLADINA STYGIA
Grouping **Analyte**					
TISSUE					
Metals Manganese (Mn)-Total (mg/kg)	54.4	129	42.5	24.8	23.1
Manganese (Mn)-Total (mg/kg wwt)	50.1	119	39.4	22.7	21.3
Mercury (Hg)-Total (mg/kg)	0.0217	0.0334	0.0190	0.0135	0.0136
Mercury (Hg)-Total (mg/kg wwt)	0.0200	0.0308	0.0176	0.0123	0.0126
Molybdenum (Mo)-Total (mg/kg)	0.038	0.086	0.097	0.036	0.028
Molybdenum (Mo)-Total (mg/kg wwt)	0.0354	0.0794	0.0900	0.0332	0.0258
Nickel (Ni)-Total (mg/kg)	0.811	0.963	0.702	2.00	0.333
Nickel (Ni)-Total (mg/kg wwt)	0.748	0.888	0.650	1.83	0.308
Phosphorus (P)-Total (mg/kg)	262	307	199	409	202
Phosphorus (P)-Total (mg/kg wwt)	241	284	184	375	187
Potassium (K)-Total (mg/kg)	700	700	520	1040	640
Potassium (K)-Total (mg/kg wwt)	650	650	483	950	589
Rhenium (Re)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Rhenium (Re)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium (Rb)-Total (mg/kg)	1.32	1.25	2.59	5.15	1.40
Rubidium (Rb)-Total (mg/kg wwt)	1.21	1.15	2.40	4.72	1.29
Selenium (Se)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Selenium (Se)-Total (mg/kg wwt)	0.028	0.037	0.045	0.021	<0.020
Sodium (Na)-Total (mg/kg)	<200 DLM	<200 DLM	<200 DLM	<200 DLM	<200 DLM
Sodium (Na)-Total (mg/kg wwt)	<40 DLM	<40 DLM	<40 DLM	<40 DLM	<40 DLM
Strontium (Sr)-Total (mg/kg)	4.82	2.37	2.34	6.21	1.48
Strontium (Sr)-Total (mg/kg wwt)	4.44	2.19	2.16	5.69	1.37
Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium (Tl)-Total (mg/kg)	0.0047	0.0082	0.0078	0.0047	0.0131
Thallium (Tl)-Total (mg/kg wwt)	0.00432	0.00755	0.00721	0.00427	0.0121
Thorium (Th)-Total (mg/kg)	0.012	0.025	0.043	<0.010	0.022
Thorium (Th)-Total (mg/kg wwt)	0.0109	0.0231	0.0401	0.0076	0.0199
Tin (Sn)-Total (mg/kg)	<0.020	0.026	0.021	<0.020	<0.020
Tin (Sn)-Total (mg/kg wwt)	0.0169	0.0237	0.0196	0.0153	0.0162
Titanium (Ti)-Total (mg/kg)	6.00	21.2	31.7	2.44	5.17
Titanium (Ti)-Total (mg/kg wwt)	5.53	19.5	29.4	2.24	4.78
Uranium (U)-Total (mg/kg)	0.0045	0.0101	0.0185	0.0024	0.0074
Uranium (U)-Total (mg/kg wwt)	0.00415	0.00932	0.0172	0.00220	0.00682
Vanadium (V)-Total (mg/kg)	0.706	1.06	1.74	0.214	0.896
Vanadium (V)-Total (mg/kg wwt)	0.651	0.976	1.61	0.196	0.828
Yttrium (Y)-Total (mg/kg)	0.094	0.226	0.219	0.051	0.092

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-16	L1232285-17	L1232285-18	L1232285-19	L1232285-20
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	18-AUG-12	18-AUG-12	16-AUG-12	14-AUG-12
	Sampled Time					
	Client ID	BJ REF NORTH 1 CLADINA STYGIA	BJ030 STER. SP.	BJ028 STER. SP.	BJ018 STER. SP.	DUP1 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Manganese (Mn)-Total (mg/kg)	68.0	18.4	46.1	13.3	225
	Manganese (Mn)-Total (mg/kg wwt)	62.7	16.7	42.8	12.3	208
	Mercury (Hg)-Total (mg/kg)	0.0192	0.0271	0.0276	0.0205	0.0290
	Mercury (Hg)-Total (mg/kg wwt)	0.0177	0.0245	0.0256	0.0191	0.0268
	Molybdenum (Mo)-Total (mg/kg)	0.098	0.242	0.142	0.213	0.070
	Molybdenum (Mo)-Total (mg/kg wwt)	0.0907	0.219	0.132	0.199	0.0649
	Nickel (Ni)-Total (mg/kg)	0.416	2.68	3.94	1.10	0.734
	Nickel (Ni)-Total (mg/kg wwt)	0.384	2.43	3.65	1.03	0.679
	Phosphorus (P)-Total (mg/kg)	213	742	578	579	327
	Phosphorus (P)-Total (mg/kg wwt)	196	672	537	538	303
	Potassium (K)-Total (mg/kg)	490	1700	2310	1820	760
	Potassium (K)-Total (mg/kg wwt)	448	1540	2140	1700	707
	Rhenium (Re)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Rhenium (Re)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Rubidium (Rb)-Total (mg/kg)	1.26	3.61	9.23	2.41	1.91
	Rubidium (Rb)-Total (mg/kg wwt)	1.16	3.27	8.57	2.24	1.76
	Selenium (Se)-Total (mg/kg)	<0.10	0.12	<0.10	<0.10	<0.10
	Selenium (Se)-Total (mg/kg wwt)	0.050	0.105	0.060	0.055	0.041
	Sodium (Na)-Total (mg/kg)	<200 DLM	<200 DLM	<200 DLM	<200 DLM	<200 DLM
	Sodium (Na)-Total (mg/kg wwt)	<40 DLM	55	<40 DLM	<40 DLM	<40 DLM
	Strontium (Sr)-Total (mg/kg)	2.87	3.13	21.2	8.09	7.16
	Strontium (Sr)-Total (mg/kg wwt)	2.65	2.83	19.7	7.52	6.62
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg)	0.0067	0.0077	0.0083	0.0052	0.0109
	Thallium (Tl)-Total (mg/kg wwt)	0.00618	0.00694	0.00773	0.00487	0.0100
	Thorium (Th)-Total (mg/kg)	0.020	0.021	0.021	0.014	0.031
	Thorium (Th)-Total (mg/kg wwt)	0.0188	0.0192	0.0194	0.0129	0.0288
	Tin (Sn)-Total (mg/kg)	0.023	<0.020	<0.020	0.025	0.072
	Tin (Sn)-Total (mg/kg wwt)	0.0210	0.0124	0.0099	0.0229	0.0662
	Titanium (Ti)-Total (mg/kg)	12.9	16.8	16.1	10.0	13.8
	Titanium (Ti)-Total (mg/kg wwt)	11.9	15.2	15.0	9.34	12.7
	Uranium (U)-Total (mg/kg)	0.0111	0.0081	0.0136	0.0054	0.0119
	Uranium (U)-Total (mg/kg wwt)	0.0102	0.00736	0.0127	0.00501	0.0110
	Vanadium (V)-Total (mg/kg)	0.577	0.824	0.888	0.496	0.869
	Vanadium (V)-Total (mg/kg wwt)	0.532	0.746	0.824	0.462	0.803
	Yttrium (Y)-Total (mg/kg)	0.084	0.444	0.349	0.086	0.140

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-21	L1232285-22			
	Description	tissue	tissue			
	Sampled Date	18-AUG-12	14-AUG-12			
	Sampled Time					
	Client ID	DUP2 CLADINA STYGIA	DUP3 CLADINA STYGIA			
Grouping	**Analyte**					
TISSUE						
Metals	Manganese (Mn)-Total (mg/kg)	79.9	33.5			
	Manganese (Mn)-Total (mg/kg wwt)	74.1	31.0			
	Mercury (Hg)-Total (mg/kg)	0.0249	0.0249			
	Mercury (Hg)-Total (mg/kg wwt)	0.0231	0.0230			
	Molybdenum (Mo)-Total (mg/kg)	0.047	0.046			
	Molybdenum (Mo)-Total (mg/kg wwt)	0.0437	0.0425			
	Nickel (Ni)-Total (mg/kg)	0.440	0.775			
	Nickel (Ni)-Total (mg/kg wwt)	0.408	0.716			
	Phosphorus (P)-Total (mg/kg)	232	273			
	Phosphorus (P)-Total (mg/kg wwt)	215	252			
	Potassium (K)-Total (mg/kg)	540	640			
	Potassium (K)-Total (mg/kg wwt)	498	589			
	Rhenium (Re)-Total (mg/kg)	<0.010	<0.010			
	Rhenium (Re)-Total (mg/kg wwt)	<0.0020	<0.0020			
	Rubidium (Rb)-Total (mg/kg)	0.874	0.864			
	Rubidium (Rb)-Total (mg/kg wwt)	0.810	0.798			
	Selenium (Se)-Total (mg/kg)	<0.10	<0.10			
	Selenium (Se)-Total (mg/kg wwt)	0.036	0.036			
	Sodium (Na)-Total (mg/kg)	<200 DLM	<200 DLM			
	Sodium (Na)-Total (mg/kg wwt)	<40 DLM	<40 DLM			
	Strontium (Sr)-Total (mg/kg)	1.98	2.36			
	Strontium (Sr)-Total (mg/kg wwt)	1.84	2.18			
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020			
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040			
	Thallium (Tl)-Total (mg/kg)	0.0049	0.0077			
	Thallium (Tl)-Total (mg/kg wwt)	0.00453	0.00708			
	Thorium (Th)-Total (mg/kg)	0.014	0.024			
	Thorium (Th)-Total (mg/kg wwt)	0.0133	0.0220			
	Tin (Sn)-Total (mg/kg)	0.023	0.024			
	Tin (Sn)-Total (mg/kg wwt)	0.0211	0.0225			
	Titanium (Ti)-Total (mg/kg)	10.6	9.53			
	Titanium (Ti)-Total (mg/kg wwt)	9.86	8.81			
	Uranium (U)-Total (mg/kg)	0.0060	0.0095			
	Uranium (U)-Total (mg/kg wwt)	0.00557	0.00873			
	Vanadium (V)-Total (mg/kg)	0.630	0.537			
	Vanadium (V)-Total (mg/kg wwt)	0.584	0.497			
	Yttrium (Y)-Total (mg/kg)	0.079	0.110			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-1	L1232285-2	L1232285-3	L1232285-4	L1232285-5
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	19-AUG-12	20-AUG-12	20-AUG-12	20-AUG-12
	Sampled Time					
	Client ID	BJ REF EAST 1 CLADINA STYGIA	BJ REF SOUTH CLADINA STYGIA	BJ CAMP 3 CLADINA STYGIA	BJ CAMP 4 CLADINA STYGIA	BJ CAMP 1 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Yttrium (Y)-Total (mg/kg wwt)	0.175	0.108	0.0942	0.111	0.191
	Zinc (Zn)-Total (mg/kg)	13.0	13.0	5.78	13.2	11.7
	Zinc (Zn)-Total (mg/kg wwt)	12.0	12.0	5.29	12.2	10.8
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Zirconium (Zr)-Total (mg/kg wwt)	0.128	0.106	0.109	0.112	0.175

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-6	L1232285-7	L1232285-8	L1232285-9	L1232285-10
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	20-AUG-12	15-AUG-12	15-AUG-12	14-AUG-12	14-AUG-12
	Sampled Time					
	Client ID	BJ CAMP 2 CLADINA STYGIA	12-7139 CLADINA STYGIA	BJ015 CLADINA STYGIA	12-7137 CLADINA STYGIA	BJ013 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Yttrium (Y)-Total (mg/kg wwt)	0.207	0.216	0.123	0.127	0.116
	Zinc (Zn)-Total (mg/kg)	14.2	14.2	8.26	20.0	8.35
	Zinc (Zn)-Total (mg/kg wwt)	13.2	13.1	7.62	18.5	7.78
	Zirconium (Zr)-Total (mg/kg)	0.25	<0.20	<0.20	0.20	<0.20
	Zirconium (Zr)-Total (mg/kg wwt)	0.229	0.115	0.090	0.186	0.084

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-11	L1232285-12	L1232285-13	L1232285-14	L1232285-15
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	14-AUG-12	19-AUG-12	17-AUG-12	19-AUG-12
	Sampled Time					
	Client ID	BJ REF NORTH 2 CLADINA STYGIA	V030 CLADINA STYGIA	BJ REF WEST CLADINA STYGIA	BJ024 CLADINA STYGIA	BJ REF EAST 2 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Yttrium (Y)-Total (mg/kg wwt)	0.0868	0.209	0.203	0.0471	0.0855
	Zinc (Zn)-Total (mg/kg)	20.5	9.64	7.49	11.3	5.78
	Zinc (Zn)-Total (mg/kg wwt)	18.9	8.89	6.94	10.3	5.34
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	0.40	<0.20	<0.20
	Zirconium (Zr)-Total (mg/kg wwt)	0.072	0.150	0.369	0.164	0.068

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-16	L1232285-17	L1232285-18	L1232285-19	L1232285-20
	Description	tissue	tissue	tissue	tissue	tissue
	Sampled Date	18-AUG-12	18-AUG-12	18-AUG-12	16-AUG-12	14-AUG-12
	Sampled Time					
	Client ID	BJ REF NORTH 1 CLADINA STYGIA	BJ030 STER. SP.	BJ028 STER. SP.	BJ018 STER. SP.	DUP1 CLADINA STYGIA
Grouping	**Analyte**					
TISSUE						
Metals	Yttrium (Y)-Total (mg/kg wwt)	0.0776	0.402	0.324	0.0805	0.129
	Zinc (Zn)-Total (mg/kg)	7.57	22.1	19.4	18.2	18.2
	Zinc (Zn)-Total (mg/kg wwt)	6.99	20.0	18.0	16.9	16.8
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Zirconium (Zr)-Total (mg/kg wwt)	0.122	0.087	0.042	0.055	0.172

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1232285-21	L1232285-22			
	Description	tissue	tissue			
	Sampled Date	18-AUG-12	14-AUG-12			
	Sampled Time					
	Client ID	DUP2 CLADINA STYGIA	DUP3 CLADINA STYGIA			
Grouping	**Analyte**					
TISSUE						
Metals	Yttrium (Y)-Total (mg/kg wwt)	0.0737	0.101			
	Zinc (Zn)-Total (mg/kg)	6.86	8.92			
	Zinc (Zn)-Total (mg/kg wwt)	6.36	8.25			
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20			
	Zirconium (Zr)-Total (mg/kg wwt)	0.080	0.109			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Boron (B)-Total	DLB	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Boron (B)-Total	DLB	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Boron (B)-Total	DLB	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Sodium (Na)-Total	DLM	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Sodium (Na)-Total	DLM	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Sodium (Na)-Total	DLM	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Sodium (Na)-Total	DLM	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Uranium (U)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Aluminum (Al)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Antimony (Sb)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Beryllium (Be)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Cesium (Cs)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Gallium (Ga)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Iron (Fe)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Rubidium (Rb)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Thallium (Tl)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Thorium (Th)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Vanadium (V)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Yttrium (Y)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Mercury (Hg)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Uranium (U)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Aluminum (Al)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Cesium (Cs)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Iron (Fe)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Rubidium (Rb)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Thallium (Tl)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Vanadium (V)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Duplicate	Yttrium (Y)-Total	DUP-H	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Calcium (Ca)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Calcium (Ca)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Calcium (Ca)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Calcium (Ca)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9

Reference Information

	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Boron (B)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Nickel (Ni)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Zinc (Zn)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Boron (B)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Nickel (Ni)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9
Method Blank	Zinc (Zn)-Total	MB-LOR	L1232285-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection limit was raised due to detection of analyte at comparable level in Method Blank.
DLM	Detection Limit Adjusted For Sample Matrix Effects
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
MB-LOR	Method Blank exceeds ALS DQO. LORs adjusted for samples with positive hits below 5 times blank level. Please contact ALS if re-analysis is required.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-DRY-CVAFS-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry, adapted from US EPA Method 245.7. This digestion procedure was implemented on October 5, 2009.

HG-WET-CVAFS-VA	Tissue	Mercury in Tissue by CVAFS (WET)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry, adapted from US EPA Method 245.7. This digestion procedure was implemented on October 5, 2009.

MET-DRY-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS (DRY)	EPA 200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on dry weight basis.

MET-DRY-ICP-VA	Tissue	Metals in Tissue by ICPOES (DRY)	EPA 200.3, EPA 6010B

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Optical Emission Spectrophotometry, adapted from US EPA Method 6010B. This digestion procedure was implemented on October 5, 2009.

MET-WET-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS (WET)	EPA 200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on wet weight basis.

MET-WET-ICP-VA	Tissue	Metals in Tissue by ICPOES (WET)	EPA 200.3, EPA 6010B

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Optical Emission Spectrophotometry, adapted from US EPA Method 6010B. This digestion procedure was implemented on October 5, 2009.

MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

1 2 3

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Short Holding Time

Rush Processing

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COC # _____

Page 1 of 3

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**	
Company: Rescan Environmental		x	Regular Service (Default)
Contact:			Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver BC V6 E 2J3	Email 1: nbush@rescan.com		Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com		Emergency Service (<1 Day / Wkend) - C
Phone: 604 689 9460		**Analysis Request**	
Invoice To:	Indicate Bottles: Filtered / Preserved (F/P) →		
Company:	**Client / Project Information:**		
Contact:	Job #: 1042-008-03-89		
Address:	PO/AFE:		
Sample	Legal Site Description:		
Phone:	Quote #:		

L1232285-COFC

Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler** *(Initials):

Sample #	Sample Identification (This description will appear on the report)		Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	Total Metals (lowest detection	Mercury(lowest detection limit)	Iron	Moisture
	BJ REF EAST 1	Cladina stygia	8/18/2012		Tissue	X	X	X	X
	BJ REF SOUTH	Cladina stygia	8/19/2012		Tissue	X	X	X	X
	BJ CAMP 3	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	BJ CAMP 4	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	BJ CAMP 1	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	BJ CAMP 2	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	12-7139	Cladina stygia	8/15/2012		Tissue	X	X	X	X
	BJ015	Cladina stygia	8/15/2012		Tissue	X	X	X	X
	12-7137	Cladina stygia	8/14/2012		Tissue	X	X	X	X
	BJ013	Cladina stygia	8/14/2012		Tissue	X	X	X	X

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:		Date & Time:		Received By:		Date & Time:	Nov 1 14:30	Sample Condition (lab use only)	
Relinquished By:		Date & Time:		Received By:		Date & Time:		Temperature 21.4	Samples Received in Good Condition? Y / N (if no provided details)

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Canada Toll Free:
www.alsglo

L1232285-COFC

COC #

Page 2 of 3

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**
Company: Rescan Environmental		x Regular Service (Default)
Contact:		Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver B	Email 1: nbush@rescan.com	Priority Service (1-Day or ASAP) ---
	Email 2: dmcallister@rescan.com	Emergency Service (<1 Day / Wkend) - Contact ALS
Phone: 604 689 9460		**Analysis Request**
Invoice To: same as report	Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:	**Client / Project Information:**	
Contact:	Job #: 1042-008-03-89	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** / **Sampler** (Initials):	

Sample #	Sample Identification (This description will appear on the report)		Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	Total Metals (lowest detection l	Mercury(lowest detection limit)	Iron	Moisture		Number of Containers
	BJ REF NORTH 2	Cladina stygia	8/18/2012		Tissue	X	X	X	X		
	V030	Cladina stygia	8/14/2012		Tissue	X	X	X	X		
	BJ REF WEST	Cladina stygia	8/19/2012		Tissue	X	X	X	X		
	BJ024	Cladina stygia	8/17/2012		Tissue	X	X	X	X		
	BJ REF East 2	Cladina stygia	8/19/2012		Tissue	X	X	X	X		
	BJ REF NORTH 1	Cladina stygia	8/18/2012		Tissue	X	X	X	X		
	BJ030	Ster. Sp.	8/18/2012		Tissue	X	X	X	X		
	BJ028	Ster. Sp.	8/18/2012		Tissue	X	X	X	X		
	BJ018	Ster. Sp.	8/16/2012		Tissue	X	X	X	X		
	Dup1	Cladina stygia	8/14/2012		Tissue	X	X	X	X		

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:		Date & Time:		Received By:	Elise	Date & Time:	Nov 1 14:30
Relinquished By:		Date & Time:		Received By:		Date & Time:	

Sample Condition (lab use only)

Temperature	Samples Received in Good Condition? Y / N (if no provided details)
21.4	

L1232285-COFC

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Page 3 of 3 _____

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**
Company: Rescan Environmental		x Regular Service (Default)
Contact:		_ Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver B	Email 1: nbush@rescan.com	Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com	Emergency Service (<1 Day / Wkend) - Co
Phone: 604 689 9460		**Analysis Request**
Invoice To: same as report	Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:	**Client / Project Information:**	
Contact:	Job #: 1042-008-03-89	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact** / **Sampler** (Initials):	

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type (select from drop-down)	Total Metals (lowest detection limit)	Mercury (lowest detection limit)	Iron	Moisture		Number of Containers
	Dup2 Cladina stygia	8/18/2012		Tissue	X	X	X	X		
	Dup3 Cladina stygia	8/14/2012		Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Elise Nov 1 14:30 21.4°C

Sample Receipt Confirmation

Report Distribution:

Company Name: RESCAN ENVIRONMENTAL SERVICES
Contact: Natasha Bush
Address: Sixth Floor, 1111 West Hastings Street Vancouver, BC, V6E 2J3
Phone: 604-689-9460
Fax: 604-687-4277
Email: nbush@rescan.com dmcallister@rescan.com
Report Name: CROSSTAB_ALS
Digital Type: --
Digital Email: --
Distribution: Hard Copy: Y Email: Y Fax: N

Invoice Distribution:

Acct Name: RESCAN ENVIRONMENTAL SERVICES
Contact: Accounts Payable
Address: Sixth Floor, 1111 West Hastings Street Vancouver, BC, V6E 2J3
Phone: 604-689-9460
Fax: --
Invoice Email: payables@rescan.com
Project #: N/A
Account #: RES100

Client Information:

Job Reference #: 1042-008-03-89
Project PO #:
Legal Site Description: N/A
Quote #: N/A
Date Sampled: 14-AUG-12
Date Received: 01-NOV-12
Sampled By:
Chain Of Custody: 1, 2, 3

Workorder Summary:

Lab Work Order #: **L1232285**
Estimated completion date: 14-DEC-12
22 Samples received at ALS in **VANCOUVER**
Client Job #: 1042-008-03-89
Account Manager: Amber Springer
Estimated sample disposal date: 13-JAN-13

Lab Sample ID	Client Sample ID	Date Sampled	Date Received	Sample Due Date	Priority Flag	Sample Type
L1232285-1	BJ REF FAST 1	18-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-2	BJ REF SOUTH	19-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-3	BJ CAMP 3	20-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-4	BJ CAMP 4	20-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-5	BJ CAMP 1	20-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-6	BJ CAMP 2	20-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-7	12-7139	15-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-8	BJ015	15-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-9	12-7137	14-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-10	BJ013	14-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-11	BJ REF NORTH 2	18-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-12	V030	14-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-13	BJ REF WEST	19-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-14	BJ024	17-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-15	BJ REF EAST 2	19-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-16	BJ REF NORTH 1	18-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-17	BJ030	18-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-18	BJ028	18-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-19	BJ018	16-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-20	DUP1	16-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-21	DUP2	18-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue
L1232285-22	DUP3	14-AUG-12 00:00	01-NOV-12 14:30	14-DEC-12		tissue

Analysis Requested :	Sample Handling and Disposal Fee	Mercury in Tissue by CVAFS [DRY]	Mercury in Tissue by CVAFS [WET]	ICPOES & ICPMS in Tissue [Dry Weight]	ICPOES & ICPMS in Tissue [Wet Weight]	% Moisture in Tissues	Tissue/Vegetation Sample Preparation
BJ REF FAST 1	✓	✓	✓	✓	✓	✓	✓
BJ REF SOUTH	✓	✓	✓	✓	✓	✓	✓
BJ CAMP 3	✓	✓	✓	✓	✓	✓	✓
BJ CAMP 4	✓	✓	✓	✓	✓	✓	✓
BJ CAMP 1	✓	✓	✓	✓	✓	✓	✓
BJ CAMP 2	✓	✓	✓	✓	✓	✓	✓
12-7139	✓	✓	✓	✓	✓	✓	✓
BJ015	✓	✓	✓	✓	✓	✓	✓
12-7137	✓	✓	✓	✓	✓	✓	✓
BJ013	✓	✓	✓	✓	✓	✓	✓
BJ REF NORTH 2	✓	✓	✓	✓	✓	✓	✓
V030	✓	✓	✓	✓	✓	✓	✓
BJ REF WEST	✓	✓	✓	✓	✓	✓	✓
BJ024	✓	✓	✓	✓	✓	✓	✓
BJ REF EAST 2	✓	✓	✓	✓	✓	✓	✓
BJ REF NORTH 1	✓	✓	✓	✓	✓	✓	✓
BJ030	✓	✓	✓	✓	✓	✓	✓
BJ028	✓	✓	✓	✓	✓	✓	✓
BJ018	✓	✓	✓	✓	✓	✓	✓
DUP1	✓	✓	✓	✓	✓	✓	✓
DUP2	✓	✓	✓	✓	✓	✓	✓
DUP3	✓	✓	✓	✓	✓	✓	✓

Sample Integrity Observations: No observations were identified for this work order submission.

ALS Group strives to deliver on-time results to our clients at all times. However, there are times when due to capacity issues or other unforeseen circumstances we are unable to meet our expected turnaround times. The information above is related to a recent workorder you have submitted to our laboratory. In the event that you have an inquiry, please refer to the Lab Work Order # when calling your Account Manager.

Short Holding Time

Rush Processing

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COC # _____

Page 1 of 3

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**	
Company: Rescan Environmental		x	Regular Service (Default)
Contact:			Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver BC V6 E 2J3	Email 1: nbush@rescan.com		Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com		Emergency Service (<1 Day / Wkend) - C
Phone: 604 689 9460		**Analysis Request**	
Invoice To:	Indicate Bottles: Filtered / Preserved (F/P) →		
Company:	**Client / Project Information:**		
Contact:	Job #: 1042-008-03-89		
Address:	PO/AFE:		
Sample	Legal Site Description:		
Phone:	Quote #:		

L1232285-COFC

Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler** *(Initials):

Sample #	Sample Identification (This description will appear on the report)		Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	Total Metals (lowest detection	Mercury(lowest detection limit)	Iron	Moisture
	BJ REF EAST 1	Cladina stygia	8/18/2012		Tissue	X	X	X	X
	BJ REF SOUTH	Cladina stygia	8/19/2012		Tissue	X	X	X	X
	BJ CAMP 3	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	BJ CAMP 4	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	BJ CAMP 1	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	BJ CAMP 2	Cladina stygia	8/20/2012		Tissue	X	X	X	X
	12-7139	Cladina stygia	8/15/2012		Tissue	X	X	X	X
	BJ015	Cladina stygia	8/15/2012		Tissue	X	X	X	X
	12-7137	Cladina stygia	8/14/2012		Tissue	X	X	X	X
	BJ013	Cladina stygia	8/14/2012		Tissue	X	X	X	X

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:		Date & Time:		Received By:		Date & Time:	Nov 1 14:30	Sample Condition (lab use only)	
Relinquished By:		Date & Time:		Received By:		Date & Time:		Temperature 21.4	Samples Received in Good Condition? Y / N (if no provided details)

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Canada Toll Free:
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L1232285-COFC

COC # _____

Page 2 of 3 _____

| | | |

L1232285-COFC

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Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Page 3 of 3 _____

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**
Company: Rescan Environmental		x Regular Service (Default)
Contact:		_ Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver B	Email 1: nbush@rescan.com	Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com	Emergency Service (<1 Day / Wkend) - Co
Phone: 604 689 9460		**Analysis Request**
Invoice To: same as report	Indicate Bottles: Filtered / Preserved (F/P) →→	
Company:	**Client / Project Information:**	
Contact:	Job #: 1042-008-03-89	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact** / **Sampler** (Initials):	

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type (select from drop-down)	Total Metals (lowest detection limit)	Mercury (lowest detection limit)	Iron	Moisture		Number of Containers
	Dup2 Cladina stygia	8/18/2012		Tissue	X	X	X	X		
	Dup3 Cladina stygia	8/14/2012		Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		
				Tissue	X	X	X	X		

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Elise Nov 1 14:30 21.4°C

Appendix 4

Berry Sample Results for *Vaccinium ovalifolium*, *Vaccinium membranaceum*, *Vaccinium uliginosum*, *Vaccinium edule*, and *Shepherdia canadensis*, 2012

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Engineers and Scientists

RESCAN ENVIRONMENTAL SERVICES
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Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1200824

Project P.O. #: NOT SUBMITTED
Job Reference: 1042-008-03-89
C of C Numbers: 1, 2, 3
Legal Site Desc:

Amber Springer
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-1	L1200824-2	L1200824-3	L1200824-4	L1200824-5
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	BJ019 VACCINIUM OVALIFOLIUM	BJ019 VACCINIUM MEMBRANACEUM	BJ020 VACCINIUM MEMBRANACEUM	LEECH SITE 1 VACCINIUM MEMBRANACEUM	LEECH SITE 1 VACCINIUM OVALIFOLIUM
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	84.0	84.9	86.0	82.9	82.6
Metals Aluminum (Al)-Total (mg/kg)	16	22	29	35	17
Aluminum (Al)-Total (mg/kg wwt)	2.6	3.4	4.1	6.1	3.0
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Antimony (Sb)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Barium (Ba)-Total (mg/kg)	16.3	20.2	16.0	15.2	12.3
Barium (Ba)-Total (mg/kg wwt)	2.61	3.05	2.24	2.60	2.15
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Beryllium (Be)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg wwt)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg)	0.032	<0.030	<0.030	0.032	<0.030
Cadmium (Cd)-Total (mg/kg wwt)	0.0051	<0.0050	<0.0050	0.0054	<0.0050
Calcium (Ca)-Total (mg/kg)	1340	1650	1280	1310	1170
Calcium (Ca)-Total (mg/kg wwt)	214	250	180	224	204
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (Cu)-Total (mg/kg)	4.23	3.92	3.53	5.90	5.81
Copper (Cu)-Total (mg/kg wwt)	0.679	0.593	0.495	1.01	1.01
Iron (Fe)-Total (mg/kg)	14.6	13.4	12.5	18.5	14.9
Iron (Fe)-Total (mg/kg wwt)	2.34	2.02	1.75	3.16	2.60
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lead (Pb)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Lithium (Li)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total (mg/kg)	593	555	537	713	636
Magnesium (Mg)-Total (mg/kg wwt)	95.1	83.8	75.3	122	111
Manganese (Mn)-Total (mg/kg)	204	169	182	287	302
Manganese (Mn)-Total (mg/kg wwt)	32.7	25.5	25.4	49.0	52.6
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury (Hg)-Total (mg/kg wwt)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Molybdenum (Mo)-Total (mg/kg)	0.460	0.420	0.417	0.111	0.136
Molybdenum (Mo)-Total (mg/kg wwt)	0.074	0.063	0.058	0.019	0.024

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-6	L1200824-7	L1200824-8	L1200824-9	L1200824-10
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	BJ030 SHEPERDIA CANADENSIS	BJ013-S1 VACCINIUM ULIGINOSUM	BJ013-S2 VACCINIUM ULIGINOSUM	SOIL 3 VACCINIUM OVALIFOLIUM	SOIL 3-1 VACCINIUM MEMBRANACEUM
Grouping **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	73.6	87.7	87.6	83.5	87.0
Metals Aluminum (Al)-Total (mg/kg)	<10	23	13	24	30
Aluminum (Al)-Total (mg/kg wwt)	<2.0	2.8	<2.0	3.9	3.9
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Antimony (Sb)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Barium (Ba)-Total (mg/kg)	3.42	10.4	11.5	12.3	8.94
Barium (Ba)-Total (mg/kg wwt)	0.903	1.27	1.43	2.02	1.17
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Beryllium (Be)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg wwt)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg)	0.040	0.108	0.120	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg wwt)	0.0105	0.0132	0.0148	<0.0050	<0.0050
Calcium (Ca)-Total (mg/kg)	949	2130	1770	1450	1020
Calcium (Ca)-Total (mg/kg wwt)	251	262	219	239	133
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (Cu)-Total (mg/kg)	4.36	3.41	3.76	4.95	2.96
Copper (Cu)-Total (mg/kg wwt)	1.15	0.418	0.465	0.815	0.387
Iron (Fe)-Total (mg/kg)	29.2	18.0	12	24	13
Iron (Fe)-Total (mg/kg wwt)	7.72	2.21	<2.0	4.0	<2.0
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lead (Pb)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<2.5	<2.5	<2.5
Lithium (Li)-Total (mg/kg wwt)	<0.10	<0.10	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	522	568	597	676	570
Magnesium (Mg)-Total (mg/kg wwt)	138	69.6	73.8	111	74.4
Manganese (Mn)-Total (mg/kg)	18.6	125	130	370	145
Manganese (Mn)-Total (mg/kg wwt)	4.92	15.4	16.1	61.0	18.9
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury (Hg)-Total (mg/kg wwt)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Molybdenum (Mo)-Total (mg/kg)	0.719	<0.050	<0.050	0.337	0.066
Molybdenum (Mo)-Total (mg/kg wwt)	0.190	<0.010	<0.010	0.056	<0.010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-11	L1200824-12	L1200824-13	L1200824-14	L1200824-15
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	SOIL 3-2 VACCINIUM MEMBRANACEUM	SOIL 2 VACCINIUM MEMBRANACEUM	SOIL 2 VACCINIUM OVALIFOLIUM	12-7166 VACCINIUM OVALIFOLIUM	12-7169 VACCINIUM OVALIFOLIUM
Grouping **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	85.6	79.5	83.8	85.8	79.2
Metals Aluminum (Al)-Total (mg/kg)	33	24	29	21	13
Aluminum (Al)-Total (mg/kg wwt)	4.7	4.8	4.7	2.9	2.8
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Antimony (Sb)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Barium (Ba)-Total (mg/kg)	9.23	16.6	15.0	19.2	7.41
Barium (Ba)-Total (mg/kg wwt)	1.33	3.40	2.43	2.74	1.54
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Beryllium (Be)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg wwt)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg wwt)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Calcium (Ca)-Total (mg/kg)	866	1230	848	1490	1060
Calcium (Ca)-Total (mg/kg wwt)	125	252	137	213	221
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (Cu)-Total (mg/kg)	3.53	5.20	2.36	5.12	4.71
Copper (Cu)-Total (mg/kg wwt)	0.508	1.06	0.382	0.729	0.979
Iron (Fe)-Total (mg/kg)	16	20	13	17	18
Iron (Fe)-Total (mg/kg wwt)	2.4	4.2	2.0	2.5	3.6
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lead (Pb)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium (Li)-Total (mg/kg)	<2.5	<2.5	<2.5	<2.5	<2.5
Lithium (Li)-Total (mg/kg wwt)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	489	730	556	620	511
Magnesium (Mg)-Total (mg/kg wwt)	70.5	149	90.0	88.3	106
Manganese (Mn)-Total (mg/kg)	109	450	139	177	240
Manganese (Mn)-Total (mg/kg wwt)	15.7	92.1	22.5	25.2	50.0
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury (Hg)-Total (mg/kg wwt)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Molybdenum (Mo)-Total (mg/kg)	0.073	0.157	0.067	0.060	0.342
Molybdenum (Mo)-Total (mg/kg wwt)	0.011	0.032	0.011	<0.010	0.071

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-16	L1200824-17	L1200824-18	L1200824-19	L1200824-20
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	12-7169 VACCINIUM MEMBRANACEUM	BJ028 VACCINIUM MEMBRANACEUM	BJ018 SHEPERDIA CANADENSIS	BJ REF SOUTH-S1 VACCINIUM ULIGINOSUM	BJ REF SOUTH-S2 VACCINIUM ULIGINOSUM
Grouping **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	85.9	83.9	73.4	85.3	84.5
Metals Aluminum (Al)-Total (mg/kg)	33	32	<10	19	20
Aluminum (Al)-Total (mg/kg wwt)	4.6	5.2	<2.0	2.8	3.1
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Antimony (Sb)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Barium (Ba)-Total (mg/kg)	11.4	18.0	1.11	22.7	19.2
Barium (Ba)-Total (mg/kg wwt)	1.61	2.91	0.294	3.32	2.97
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Beryllium (Be)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg wwt)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg)	<0.030	<0.030	<0.030	0.343	0.307
Cadmium (Cd)-Total (mg/kg wwt)	<0.0050	<0.0050	<0.0050	0.0503	0.0475
Calcium (Ca)-Total (mg/kg)	1010	1550	678	1620	1830
Calcium (Ca)-Total (mg/kg wwt)	142	250	180	237	284
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (Cu)-Total (mg/kg)	4.84	5.35	3.32	3.05	2.54
Copper (Cu)-Total (mg/kg wwt)	0.682	0.864	0.882	0.447	0.392
Iron (Fe)-Total (mg/kg)	27	21	20	20	19
Iron (Fe)-Total (mg/kg wwt)	3.9	3.4	5.3	3.0	2.9
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	0.11	<0.10
Lead (Pb)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium (Li)-Total (mg/kg)	<2.5	<2.5	<2.5	<2.5	<2.5
Lithium (Li)-Total (mg/kg wwt)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	478	675	306	622	546
Magnesium (Mg)-Total (mg/kg wwt)	67.3	109	81.4	91.2	84.5
Manganese (Mn)-Total (mg/kg)	160	171	8.94	128	116
Manganese (Mn)-Total (mg/kg wwt)	22.6	27.6	2.38	18.8	17.9
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury (Hg)-Total (mg/kg wwt)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Molybdenum (Mo)-Total (mg/kg)	0.157	0.114	0.481	0.092	0.088
Molybdenum (Mo)-Total (mg/kg wwt)	0.022	0.018	0.128	0.014	0.014

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-21	L1200824-22	L1200824-23	L1200824-24	L1200824-25
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	BJ REF EAST VACCINIUM ULIGINOSUM	BJ024 VACCINIUM OVALIFOLIUM	SOIL 4 VACCINIUM MEMBRANACEUM	12-7168 VACCINIUM OVALIFOLIUM	12-7167 VACCINIUM OVALIFOLIUM
Grouping **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	84.7	81.2	84.6	83.3	84.2
Metals Aluminum (Al)-Total (mg/kg)	21	17	35	62	37
Aluminum (Al)-Total (mg/kg wwt)	3.2	3.1	5.4	10.3	5.9
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Antimony (Sb)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Barium (Ba)-Total (mg/kg)	25.2	7.65	13.7	23.8	18.3
Barium (Ba)-Total (mg/kg wwt)	3.84	1.43	2.11	3.97	2.90
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Beryllium (Be)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg wwt)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg)	0.061	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg wwt)	0.0093	<0.0050	<0.0050	<0.0050	<0.0050
Calcium (Ca)-Total (mg/kg)	1280	1160	971	1730	1390
Calcium (Ca)-Total (mg/kg wwt)	196	217	150	290	220
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (Cu)-Total (mg/kg)	3.55	6.24	3.81	8.78	6.92
Copper (Cu)-Total (mg/kg wwt)	0.542	1.17	0.587	1.47	1.09
Iron (Fe)-Total (mg/kg)	19	19	18	51	31
Iron (Fe)-Total (mg/kg wwt)	2.8	3.5	2.7	8.5	4.9
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lead (Pb)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium (Li)-Total (mg/kg)	<2.5	<2.5	<2.5	<2.5	<2.5
Lithium (Li)-Total (mg/kg wwt)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	473	763	554	825	714
Magnesium (Mg)-Total (mg/kg wwt)	72.2	143	85.3	138	113
Manganese (Mn)-Total (mg/kg)	50.0	329	170	167	397
Manganese (Mn)-Total (mg/kg wwt)	7.63	61.6	26.2	28.0	62.8
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	0.0118	<0.0050
Mercury (Hg)-Total (mg/kg wwt)	<0.0010	<0.0010	<0.0010	0.0020	<0.0010
Molybdenum (Mo)-Total (mg/kg)	<0.050	1.70	0.055	0.294	0.226
Molybdenum (Mo)-Total (mg/kg wwt)	<0.010	0.318	<0.010	0.049	0.036

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-26	L1200824-27	L1200824-28	L1200824-29	L1200824-30
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	SOIL 1 VIBURNUM EDULE	SOIL 1 VACCINIUM MEMBRANACEUM	SOAP 1 SHEPERDIA CANADENSIS	BJ029 VACCINIUM OVALIFOLIUM	BJ030 VACCINIUM MEMBRANACEUM
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	85.3	82.1	75.8	81.8	86.1
Metals Aluminum (Al)-Total (mg/kg)	<10	39	12	<10	49
Aluminum (Al)-Total (mg/kg wwt)	<2.0	7.0	2.8	<2.0	6.9
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Antimony (Sb)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Barium (Ba)-Total (mg/kg)	10.5	25.9	4.07	4.76	38.1
Barium (Ba)-Total (mg/kg wwt)	1.54	4.64	0.986	0.866	5.28
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Beryllium (Be)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg wwt)	<0.030	<0.030	<0.030	<0.030	<0.030
Cadmium (Cd)-Total (mg/kg)	<0.030	0.048	0.038	<0.030	0.169
Cadmium (Cd)-Total (mg/kg wwt)	<0.0050	0.0086	0.0093	<0.0050	0.0235
Calcium (Ca)-Total (mg/kg)	1470	5060	2290	2220	2380
Calcium (Ca)-Total (mg/kg wwt)	217	907	555	404	329
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Cobalt (Co)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (Cu)-Total (mg/kg)	1.31	6.48	5.41	4.41	6.35
Copper (Cu)-Total (mg/kg wwt)	0.192	1.16	1.31	0.801	0.880
Iron (Fe)-Total (mg/kg)	<10 DLIV	24	44	23	26
Iron (Fe)-Total (mg/kg wwt)	<2.0	4.4	10.6	4.1	3.6
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lead (Pb)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium (Li)-Total (mg/kg)	<2.5	<2.5	<2.5	<2.5	<2.5
Lithium (Li)-Total (mg/kg wwt)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	402	681	514	517	775
Magnesium (Mg)-Total (mg/kg wwt)	59.0	122	124	93.9	107
Manganese (Mn)-Total (mg/kg)	15.4	296	19.9	19.0	274
Manganese (Mn)-Total (mg/kg wwt)	2.27	53.0	4.82	3.45	38.0
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury (Hg)-Total (mg/kg wwt)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Molybdenum (Mo)-Total (mg/kg)	<0.050	0.157	1.25	0.370	0.050
Molybdenum (Mo)-Total (mg/kg wwt)	<0.010	0.028	0.303	0.067	<0.010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1200824-31				
	Description	TISSUE				
	Sampled Date					
	Sampled Time					
	Client ID	SOIL 4 VACCINIUM OVALIFOLIUM				
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	84.5				
Metals	Aluminum (Al)-Total (mg/kg)	35				
	Aluminum (Al)-Total (mg/kg wwt)	5.5				
	Antimony (Sb)-Total (mg/kg)	<0.050				
	Antimony (Sb)-Total (mg/kg wwt)	<0.010				
	Arsenic (As)-Total (mg/kg)	<0.050				
	Arsenic (As)-Total (mg/kg wwt)	<0.010				
	Barium (Ba)-Total (mg/kg)	10.5				
	Barium (Ba)-Total (mg/kg wwt)	1.62				
	Beryllium (Be)-Total (mg/kg)	<0.30				
	Beryllium (Be)-Total (mg/kg wwt)	<0.10				
	Bismuth (Bi)-Total (mg/kg)	<0.30				
	Bismuth (Bi)-Total (mg/kg wwt)	<0.030				
	Cadmium (Cd)-Total (mg/kg)	<0.030				
	Cadmium (Cd)-Total (mg/kg wwt)	<0.0050				
	Calcium (Ca)-Total (mg/kg)	1030				
	Calcium (Ca)-Total (mg/kg wwt)	159				
	Chromium (Cr)-Total (mg/kg)	<0.50				
	Chromium (Cr)-Total (mg/kg wwt)	<0.10				
	Cobalt (Co)-Total (mg/kg)	<0.10				
	Cobalt (Co)-Total (mg/kg wwt)	<0.020				
	Copper (Cu)-Total (mg/kg)	4.47				
	Copper (Cu)-Total (mg/kg wwt)	0.692				
	Iron (Fe)-Total (mg/kg)	38				
	Iron (Fe)-Total (mg/kg wwt)	5.8				
	Lead (Pb)-Total (mg/kg)	<0.10				
	Lead (Pb)-Total (mg/kg wwt)	<0.020				
	Lithium (Li)-Total (mg/kg)	<2.5				
	Lithium (Li)-Total (mg/kg wwt)	<0.50				
	Magnesium (Mg)-Total (mg/kg)	598				
	Magnesium (Mg)-Total (mg/kg wwt)	92.5				
	Manganese (Mn)-Total (mg/kg)	253				
	Manganese (Mn)-Total (mg/kg wwt)	39.1				
	Mercury (Hg)-Total (mg/kg)	<0.0050				
	Mercury (Hg)-Total (mg/kg wwt)	<0.0010				
	Molybdenum (Mo)-Total (mg/kg)	0.231				
	Molybdenum (Mo)-Total (mg/kg wwt)	0.036				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-1	L1200824-2	L1200824-3	L1200824-4	L1200824-5
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	BJ019 VACCINIUM OVALIFOLIUM	BJ019 VACCINIUM MEMBRANACEUM	BJ020 VACCINIUM MEMBRANACEUM	LEECH SITE 1 VACCINIUM MEMBRANACEUM	LEECH SITE 1 VACCINIUM OVALIFOLIUM
Grouping / **Analyte**					
TISSUE					
Metals Nickel (Ni)-Total (mg/kg)	<0.50	0.50	<0.50	1.12	0.86
Nickel (Ni)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	0.19	0.15
Phosphorus (P)-Total (mg/kg)	1220	1220	1130	1460	1430
Phosphorus (P)-Total (mg/kg wwt)	195	185	159	249	249
Potassium (K)-Total (mg/kg)	5950	5010	6290	6200	6700
Potassium (K)-Total (mg/kg wwt)	954	757	881	1060	1170
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Selenium (Se)-Total (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium (Na)-Total (mg/kg)	<100	<100	<100	<100	<100
Sodium (Na)-Total (mg/kg wwt)	<20	<20	<20	<20	<20
Strontium (Sr)-Total (mg/kg)	2.21	3.89	2.14	4.79	3.87
Strontium (Sr)-Total (mg/kg wwt)	0.354	0.587	0.300	0.819	0.676
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Thallium (Tl)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	0.25	<0.20
Tin (Sn)-Total (mg/kg wwt)	<0.050	<0.050	<0.050	<0.050	<0.050
Titanium (Ti)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Titanium (Ti)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Vanadium (V)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc (Zn)-Total (mg/kg)	6.98	6.69	5.85	8.53	7.57
Zinc (Zn)-Total (mg/kg wwt)	1.12	1.01	0.82	1.46	1.32

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1200824-6 TISSUE BJ030 SHEPERDIA CANADENSIS	L1200824-7 TISSUE BJ013-S1 VACCINIUM ULIGINOSUM	L1200824-8 TISSUE BJ013-S2 VACCINIUM ULIGINOSUM	L1200824-9 TISSUE SOIL 3 VACCINIUM OVALIFOLIUM	L1200824-10 TISSUE SOIL 3-1 VACCINIUM MEMBRANACEUM
Sample ID		L1200824-6	L1200824-7	L1200824-8	L1200824-9	L1200824-10
Description		TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date						
Sampled Time						
Client ID		BJ030 SHEPERDIA CANADENSIS	BJ013-S1 VACCINIUM ULIGINOSUM	BJ013-S2 VACCINIUM ULIGINOSUM	SOIL 3 VACCINIUM OVALIFOLIUM	SOIL 3-1 VACCINIUM MEMBRANACEUM
TISSUE						
Metals	Nickel (Ni)-Total (mg/kg)	9.16	<0.50	0.59	0.54	0.63
	Nickel (Ni)-Total (mg/kg wwt)	2.42	<0.10	<0.10	<0.10	<0.10
	Phosphorus (P)-Total (mg/kg)	1730	972	1170	1620	1160
	Phosphorus (P)-Total (mg/kg wwt)	457	119	144	266	152
	Potassium (K)-Total (mg/kg)	7850	6190	7500	6600	5800
	Potassium (K)-Total (mg/kg wwt)	2080	759	920	1090	760
	Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium (Se)-Total (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na)-Total (mg/kg)	<100	<100	<1000 DLIV	<1000 DLIV	<1000 DLIV
	Sodium (Na)-Total (mg/kg wwt)	<20	<20	<200 DLIV	<200 DLIV	<200 DLIV
	Strontium (Sr)-Total (mg/kg)	5.42	6.08	5.17	2.58	2.47
	Strontium (Sr)-Total (mg/kg wwt)	1.43	0.746	0.639	0.426	0.322
	Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
	Thallium (Tl)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
	Tin (Sn)-Total (mg/kg)	<0.20	<0.20	1.21	0.95	1.62
	Tin (Sn)-Total (mg/kg wwt)	<0.050	<0.050	0.150	0.156	0.211
	Titanium (Ti)-Total (mg/kg)	0.74	0.90	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV
	Titanium (Ti)-Total (mg/kg wwt)	0.20	0.11	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV
	Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Vanadium (V)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	12.3	17.0	19.0	9.23	8.63
	Zinc (Zn)-Total (mg/kg wwt)	3.26	2.08	2.35	1.52	1.13

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1200824-11 TISSUE SOIL 3-2 VACCINIUM MEMBRANACEUM	L1200824-12 TISSUE SOIL 2 VACCINIUM MEMBRANACEUM	L1200824-13 TISSUE SOIL 2 VACCINIUM OVALIFOLIUM	L1200824-14 TISSUE 12-7166 VACCINIUM OVALIFOLIUM	L1200824-15 TISSUE 12-7169 VACCINIUM OVALIFOLIUM
TISSUE						
Metals	Nickel (Ni)-Total (mg/kg)	0.67	0.72	<0.50	1.06	0.77
	Nickel (Ni)-Total (mg/kg wwt)	<0.10	0.15	<0.10	0.15	0.16
	Phosphorus (P)-Total (mg/kg)	1300	1360	970	1240	1310
	Phosphorus (P)-Total (mg/kg wwt)	188	279	157	176	273
	Potassium (K)-Total (mg/kg)	5100	5400	5900	8200	6600
	Potassium (K)-Total (mg/kg wwt)	740	1110	960	1160	1360
	Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium (Se)-Total (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na)-Total (mg/kg)	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV
	Sodium (Na)-Total (mg/kg wwt)	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV
	Strontium (Sr)-Total (mg/kg)	2.92	1.80	1.45	5.02	2.57
	Strontium (Sr)-Total (mg/kg wwt)	0.420	0.368	0.235	0.715	0.535
	Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
	Thallium (Tl)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
	Tin (Sn)-Total (mg/kg)	1.33	0.74	1.26	1.28	0.86
	Tin (Sn)-Total (mg/kg wwt)	0.192	0.151	0.205	0.182	0.179
	Titanium (Ti)-Total (mg/kg)	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV
	Titanium (Ti)-Total (mg/kg wwt)	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV
	Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Vanadium (V)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	7.50	7.66	4.28	6.37	7.63
	Zinc (Zn)-Total (mg/kg wwt)	1.08	1.57	0.69	0.91	1.59

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1200824-16 TISSUE 12-7169 VACCINIUM MEMBRANACEUM	L1200824-17 TISSUE BJ028 VACCINIUM MEMBRANACEUM	L1200824-18 TISSUE BJ018 SHEPERDIA CANADENSIS	L1200824-19 TISSUE BJ REF SOUTH-S1 VACCINIUM ULIGINOSUM	L1200824-20 TISSUE BJ REF SOUTH-S2 VACCINIUM ULIGINOSUM
TISSUE						
Metals	Nickel (Ni)-Total (mg/kg)	0.75	0.76	3.03	0.74	0.59
	Nickel (Ni)-Total (mg/kg wwt)	0.11	0.12	0.81	0.11	<0.10
	Phosphorus (P)-Total (mg/kg)	1310	1630	1500	1220	1230
	Phosphorus (P)-Total (mg/kg wwt)	185	264	398	178	190
	Potassium (K)-Total (mg/kg)	7100	6000	7700	6400	6500
	Potassium (K)-Total (mg/kg wwt)	1000	960	2050	930	1010
	Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium (Se)-Total (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na)-Total (mg/kg)	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV
	Sodium (Na)-Total (mg/kg wwt)	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV
	Strontium (Sr)-Total (mg/kg)	2.97	8.22	3.21	2.83	2.59
	Strontium (Sr)-Total (mg/kg wwt)	0.419	1.33	0.853	0.414	0.401
	Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
	Thallium (Tl)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
	Tin (Sn)-Total (mg/kg)	2.74	1.25	0.43	0.91	0.59
	Tin (Sn)-Total (mg/kg wwt)	0.386	0.201	0.115	0.134	0.091
	Titanium (Ti)-Total (mg/kg)	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV
	Titanium (Ti)-Total (mg/kg wwt)	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV
	Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Vanadium (V)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	6.44	8.40	7.11	21.4	19.1
	Zinc (Zn)-Total (mg/kg wwt)	0.91	1.36	1.89	3.13	2.95

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1200824-21 TISSUE BJ REF EAST VACCINIUM ULIGINOSUM	L1200824-22 TISSUE BJ024 VACCINIUM OVALIFOLIUM	L1200824-23 TISSUE SOIL 4 VACCINIUM MEMBRANACEUM	L1200824-24 TISSUE 12-7168 VACCINIUM OVALIFOLIUM	L1200824-25 TISSUE 12-7167 VACCINIUM OVALIFOLIUM
TISSUE						
Metals	Nickel (Ni)-Total (mg/kg)	0.84	1.10	0.64	1.16	0.75
	Nickel (Ni)-Total (mg/kg wwt)	0.13	0.21	<0.10	0.19	0.12
	Phosphorus (P)-Total (mg/kg)	1390	1760	1130	2350	2290
	Phosphorus (P)-Total (mg/kg wwt)	212	331	174	393	363
	Potassium (K)-Total (mg/kg)	6400	6700	4700	10300	10200
	Potassium (K)-Total (mg/kg wwt)	970	1260	730	1710	1610
	Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium (Se)-Total (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
	Sodium (Na)-Total (mg/kg)	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV
	Sodium (Na)-Total (mg/kg wwt)	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV
	Strontium (Sr)-Total (mg/kg)	13.9	3.02	11.0	9.38	2.16
	Strontium (Sr)-Total (mg/kg wwt)	2.12	0.566	1.70	1.57	0.341
	Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
	Thallium (Tl)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
	Tin (Sn)-Total (mg/kg)	1.29	0.93	1.08	1.17	1.23
	Tin (Sn)-Total (mg/kg wwt)	0.197	0.174	0.166	0.196	0.195
	Titanium (Ti)-Total (mg/kg)	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV
	Titanium (Ti)-Total (mg/kg wwt)	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV
	Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Vanadium (V)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	17.2	10.6	5.01	11.3	9.95
	Zinc (Zn)-Total (mg/kg wwt)	2.63	1.99	0.77	1.89	1.57

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1200824-26	L1200824-27	L1200824-28	L1200824-29	L1200824-30
Description	TISSUE	TISSUE	TISSUE	TISSUE	TISSUE
Sampled Date					
Sampled Time					
Client ID	SOIL 1 VIBURNUM EDULE	SOIL 1 VACCINIUM MEMBRANACEUM	SOAP 1 SHEPERDIA CANADENSIS	BJ029 VACCINIUM OVALIFOLIUM	BJ030 VACCINIUM MEMBRANACEUM
Grouping / **Analyte**					
TISSUE					
Metals Nickel (Ni)-Total (mg/kg)	<0.50	1.45	4.95	0.69	2.36
Nickel (Ni)-Total (mg/kg wwt)	<0.10	0.26	1.20	0.13	0.33
Phosphorus (P)-Total (mg/kg)	740	1830	1820	1470	2000
Phosphorus (P)-Total (mg/kg wwt)	110	329	440	267	278
Potassium (K)-Total (mg/kg)	6900	5800	9800	6500	7300
Potassium (K)-Total (mg/kg wwt)	1020	1030	2370	1170	1020
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Selenium (Se)-Total (mg/kg wwt)	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium (Na)-Total (mg/kg)	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV	<1000 DLIV
Sodium (Na)-Total (mg/kg wwt)	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV	<200 DLIV
Strontium (Sr)-Total (mg/kg)	12.8	5.18	5.65	4.64	6.92
Strontium (Sr)-Total (mg/kg wwt)	1.88	0.928	1.37	0.843	0.960
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Thallium (Tl)-Total (mg/kg wwt)	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total (mg/kg)	0.69	0.87	0.77	1.31	1.03
Tin (Sn)-Total (mg/kg wwt)	0.102	0.156	0.186	0.237	0.142
Titanium (Ti)-Total (mg/kg)	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV	<5.0 DLIV
Titanium (Ti)-Total (mg/kg wwt)	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV	<1.0 DLIV
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Total (mg/kg wwt)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Vanadium (V)-Total (mg/kg wwt)	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc (Zn)-Total (mg/kg)	7.04	15.3	11.4	8.92	12.2
Zinc (Zn)-Total (mg/kg wwt)	1.04	2.74	2.77	1.62	1.70

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1200824-31				
	Description	TISSUE				
	Sampled Date					
	Sampled Time					
	Client ID	SOIL 4 VACCINIUM OVALIFOLIUM				
Grouping	**Analyte**					
TISSUE						
Metals	Nickel (Ni)-Total (mg/kg)	0.66				
	Nickel (Ni)-Total (mg/kg wwt)	0.10				
	Phosphorus (P)-Total (mg/kg)	1480				
	Phosphorus (P)-Total (mg/kg wwt)	229				
	Potassium (K)-Total (mg/kg)	5500				
	Potassium (K)-Total (mg/kg wwt)	840				
	Selenium (Se)-Total (mg/kg)	<1.0				
	Selenium (Se)-Total (mg/kg wwt)	<0.20				
	Sodium (Na)-Total (mg/kg)	<1000 DLIV				
	Sodium (Na)-Total (mg/kg wwt)	<200 DLIV				
	Strontium (Sr)-Total (mg/kg)	6.97				
	Strontium (Sr)-Total (mg/kg wwt)	1.08				
	Thallium (Tl)-Total (mg/kg)	<0.030				
	Thallium (Tl)-Total (mg/kg wwt)	<0.010				
	Tin (Sn)-Total (mg/kg)	1.67				
	Tin (Sn)-Total (mg/kg wwt)	0.258				
	Titanium (Ti)-Total (mg/kg)	<5.0 DLIV				
	Titanium (Ti)-Total (mg/kg wwt)	<1.0 DLIV				
	Uranium (U)-Total (mg/kg)	<0.010				
	Uranium (U)-Total (mg/kg wwt)	<0.0020				
	Vanadium (V)-Total (mg/kg)	<0.50				
	Vanadium (V)-Total (mg/kg wwt)	<0.10				
	Zinc (Zn)-Total (mg/kg)	7.16				
	Zinc (Zn)-Total (mg/kg wwt)	1.11				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Copper (Cu)-Total	DUP-H	L1200824-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -8, -9
Duplicate	Magnesium (Mg)-Total	DUP-H	L1200824-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -8, -9
Duplicate	Copper (Cu)-Total	DUP-H	L1200824-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -8, -9
Duplicate	Magnesium (Mg)-Total	DUP-H	L1200824-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLIV	Detection Limit Adjusted: Lower Initial Volume
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-DRY-CVAFS-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry, adapted from US EPA Method 245.7. This digestion procedure was implemented on October 5, 2009.

HG-WET-CVAFS-VA	Tissue	Mercury in Tissue by CVAFS (WET)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry, adapted from US EPA Method 245.7. This digestion procedure was implemented on October 5, 2009.

MET-DRY-ICP-VA	Tissue	Metals in Tissue by ICPOES (DRY)	EPA 200.3, EPA 6010B

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Optical Emission Spectrophotometry, adapted from US EPA Method 6010B. This digestion procedure was implemented on October 5, 2009.

MET-DRY-MS-VA	Tissue	Metals in Tissue by ICPMS (DRY)	EPA 200.3, EPA 6020A

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Mass Spectrometry, adapted from US EPA Method 6020A. This digestion procedure was implemented on October 5, 2009

MET-WET-ICP-VA	Tissue	Metals in Tissue by ICPOES (WET)	EPA 200.3, EPA 6010B

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Optical Emission Spectrophotometry, adapted from US EPA Method 6010B. This digestion procedure was implemented on October 5, 2009.

MET-WET-MS-VA	Tissue	Metals in Tissue by ICPMS (WET)	EPA 200.3, EPA 6020A

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Mass Spectrometry, adapted from US EPA Method 6020A. This digestion procedure was implemented on October 5, 2009

MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

1 2 3

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1200824-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Page 1 of 3

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**
Company: Rescan Environmental		x Regular Service (Default)
Contact:		Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver BC V6 E 2J3	Email 1: nbush@rescan.com	Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com	Emergency Service (<1 Day / Wkend) - Contact ALS
Phone: 604 689 9460		**Analysis Request**
Invoice To: same as report	Indicate Bottles: Filtered / Preserved (F/P) →	
Company:	**Client / Project Information:**	
Contact:	Job #: 1042-008-03-89	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone:	Quote #:	
Lab Work Order # (lab use only): L1200824	**ALS Contact:**	**Sampler** (Initials):

Sample #	Sample Identification (This description will appear on the report)		Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	Total Metals (residential detect	Mercury(lowest detection limit)	Iron	Moisture							Hazardous?	Highly Contaminated?	Number of Containers
	BJ019	Vaccinium ovalifolium			Tissue	X	X	X	X									
	BJ019	Vaccinium membranaceum			Tissue	X	X	X	X									
	BJ020	Vaccinium membranaceum			Tissue	X	X	X	X									
	Leech Site 1	Vaccinium membranaceum			Tissue	X	X	X	X									
	Leech Site 1	Vaccinium ovalifolium			Tissue	X	X	X	X									
	BJ030	Shepherdia canadensis			Tissue	X	X	X	X									
	BJ013-S1	Vaccinium uliginosum			Tissue	X	X	X	X									
	BJ013-S2	Vaccinium uliginosum			Tissue	X	X	X	X									
	Soil 3	Vaccinium ovalifolium			Tissue	X	X	X	X									
	Soil 3-1	Vaccinium membranaceum			Tissue	X	X	X	X									

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:		Date & Time:		Received By:		Date & Time: 17:00	08/29/2012	**Sample Condition (lab use only)**	
Relinquished By:		Date & Time:		Received By:		Date & Time:		Temperature: 8.7°C	Samples Received in Good Condition? Y / N (if no provided details)

Short Holding Time

Rush Processing

L1200824-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**
Company: Rescan Environmental		x Regular Service (Default)
Contact:		Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver BC V6 E 2J3	Email 1: nbush@rescan.com	Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com	Emergency Service (<1 Day / Wkend) - Contact ALS
Phone: 604 689 9460		**Analysis Request**
Invoice To: same as report	Indicate Bottles: Filtered / Preserved (F/P) →	
Company:	**Client / Project Information:**	
Contact:	Job #: 1042-008-03-89	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** / **Sampler** (Initials):	

Sample #	Sample Identification (This description will appear on the report)		Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	Total Metals (residential detect	Mercury(lowest detection limit)	Iron	Moisture							Hazardous?	Highly Contaminated?	Number of Containers
	Soil 3-2	Vaccinium membranaceum			Tissue	X	X	X	X									
	Soil 2	Vaccinium membranaceum			Tissue	X	X	X	X									
	Soil 2	Vaccinium ovalifolium			Tissue	X	X	X	X									
	12-7166	Vaccinium ovalifolium			Tissue	X	X	X	X									
	12-7169	Vaccinium ovalifolium			Tissue	X	X	X	X									
	12-7169	Vaccinium membranaceum			Tissue	X	X	X	X									
	BJ028	Vaccinium membranaceum			Tissue	X	X	X	X									
	BJ018	Shepherdia canadensis			Tissue	X	X	X	X									
	BJ REF south- s1	Vaccinium uliginosum			Tissue	X	X	X	X									
	BJ REF south- s2	Vaccinium uliginosum			Tissue	X	X	X	X									

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:		Date & Time:		Received By:		Date & Time: 17:00	08/27/202	Sample Condition (lab use only)
Relinquished By:		Date & Time:		Received By:		Date & Time:		Temperature 0.7°C / Samples Received in Good Condition? Y / N (If no provided details)

L1200824-COFC

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Report to: Natasha Bush	**Report Format / Distribution**	**Service Requested:**
Company: Rescan Environmental		x Regular Service (Default)
Contact:		Rush Service (2-3 Days)
Address: 1111 West Hastings Street Vancouver BC V6 E 2J3	Email 1: nbush@rescan.com	Priority Service (1 Day or ASAP)
	Email 2: dmcallister@rescan.com	Emergency Service (<1 Day / Wkend) - Contact ALS
Phone: 604 689 9460		**Analysis Request**
Invoice To: same as report	Indicate Bottles: Filtered / Preserved (F/P) →	
Company:	**Client / Project Information:**	
Contact:	Job #: 1042-008-03-89	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:**	**Sampler** (Initials):

Sample #	Sample Identification (This description will appear on the report)		Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	Total Metals (residential detect	Mercury(lowest detection limit)	Iron	Moisture							Hazardous?	Highly Contaminated?	Number of Containers
	BJ ref East	Vaccinium uliginosum			Tissue	X	X	X	X									
	BJ024	Vaccinium ovalifolium			Tissue	X	X	X	X									
	Soil 4	AMBER COULD YOU CALL ABOUT THIS ONE			Tissue	X	X	X	X									
	12-7168	Vaccinium ovalifolium			Tissue	X	X	X	X									
	12-7167	Vaccinium ovalifolium			Tissue	X	X	X	X									
	Soil 1	Viburnum edule			Tissue	X	X	X	X									
	Soil 1	Vaccinium membranaceum			Tissue	X	X	X	X									
	Soap 1	Sheperdia canadensis			Tissue	X	X	X	X									
	BJ029	Vaccinium ovalifolium			Tissue	X	X	X	X									
	BJ030	Vaccinium membranaceum			Tissue	X	X	X	X									

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	please report in both wet and dry weights

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By:		Date & Time:		Received By:	Michelle	Date & Time: 17:00	8/27/2012	Sample Condition (lab use only)
Relinquished By:		Date & Time:		Received By:		Date & Time:		Temperature 0.7°C / Samples Received in Good Condition? Y / N (if no provided details)

Appendix 5

Sedge Sample Results for *Carex* sp., 2012

Rescan™
Engineers and Scientists

RESCAN ENVIRONMENTAL SERVICES
ATTN: Wade Brunham
Sixth Floor
1111 West Hastings Street
Vancouver BC V6E 2J3

Date Received: 06-JUL-12
Report Date: 03-AUG-12 11:45 (MT)
Version: FINAL

Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1174120

Project P.O. #: NOT SUBMITTED
Job Reference: 1042-008-03
C of C Numbers:
Legal Site Desc:

Amber Springer
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1174120-1	L1174120-2	L1174120-3	L1174120-4	L1174120-5
Description	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE
Sampled Date	21-JUN-12	21-JUN-12	21-JUN-12	22-JUN-12	22-JUN-12
Sampled Time					
Client ID	W005- REP 1	W005- REP 2	W005- REP 3	W009- REP 1	W009- REP 2
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	72.5	72.6	74.6	70.5	77.0
Metals Aluminum (Al)-Total (mg/kg)	<10	<10	<10	<10	<10
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Barium (Ba)-Total (mg/kg)	9.98	13.5	11.8	11.1	8.65
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium (Cd)-Total (mg/kg)	0.775	1.00	1.74	<0.030	<0.030
Calcium (Ca)-Total (mg/kg)	1930	1810	1430	4500	8520
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Copper (Cu)-Total (mg/kg)	19.5	21.8	14.6	0.915	0.929
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	979	876	1020	1190	1390
Manganese (Mn)-Total (mg/kg)	235	229	159	334	306
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)-Total (mg/kg)	0.208	0.286	0.226	0.120	0.117
Nickel (Ni)-Total (mg/kg)	6.21	5.59	4.29	<0.50	<0.50
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium (Sr)-Total (mg/kg)	14.0	12.7	10.5	22.7	38.0
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Total (mg/kg)	55.9	51.9	50.5	19.3	24.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1174120-6	L1174120-7	L1174120-8	L1174120-9	L1174120-10
Description	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE
Sampled Date	22-JUN-12	22-JUN-12	22-JUN-12	22-JUN-12	23-JUN-12
Sampled Time					
Client ID	W009- REP 3	W012- REP 1	W012- REP 2	W012- REP 3	W023- REP 1
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	73.5	68.3	67.8	69.6	68.2
Metals Aluminum (Al)-Total (mg/kg)	<10	<10	<10	<10	<10
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg)	0.058	0.123	<0.050	<0.050	0.255
Barium (Ba)-Total (mg/kg)	7.84	4.81	13.2	13.7	15.1
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium (Cd)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Calcium (Ca)-Total (mg/kg)	5060	1320	1580	1420	2650
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	0.10	0.12
Copper (Cu)-Total (mg/kg)	0.967	7.02	6.75	6.54	9.60
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	1120	1080	1180	1120	1540
Manganese (Mn)-Total (mg/kg)	336	96.7	132	183	187
Mercury (Hg)-Total (mg/kg)	<0.0050	0.0051	0.0079	0.0051	<0.0050
Molybdenum (Mo)-Total (mg/kg)	0.166	0.826	0.491	0.615	0.205
Nickel (Ni)-Total (mg/kg)	<0.50	1.22	1.71	1.49	1.79
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium (Sr)-Total (mg/kg)	20.2	5.41	6.89	5.90	18.4
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Total (mg/kg)	39.9	19.0	21.0	22.6	32.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1174120-11	L1174120-12	L1174120-13	L1174120-14	L1174120-15
Description	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE
Sampled Date	23-JUN-12	23-JUN-12	24-JUN-12	24-JUN-12	24-JUN-12
Sampled Time					
Client ID	W023- REP 2	W023- REP 3	W025- REP 1	W025- REP 2	W025- REP 3
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	68.8	68.6	74.1	72.8	75.2
Metals Aluminum (Al)-Total (mg/kg)	<10	<10	<10	<10	<10
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg)	0.114	0.062	<0.050	<0.050	<0.050
Barium (Ba)-Total (mg/kg)	15.1	18.3	13.6	6.33	9.43
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium (Cd)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Calcium (Ca)-Total (mg/kg)	2300	3440	2240	1360	2090
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Total (mg/kg)	0.12	0.11	0.47	0.53	0.17
Copper (Cu)-Total (mg/kg)	8.02	7.51	7.72	6.40	5.46
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	1360	1340	1250	1130	1400
Manganese (Mn)-Total (mg/kg)	157	209	472	599	293
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	0.0084	<0.0050	0.0053
Molybdenum (Mo)-Total (mg/kg)	0.265	0.188	0.499	0.099	0.163
Nickel (Ni)-Total (mg/kg)	2.08	1.59	2.24	1.86	1.28
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium (Sr)-Total (mg/kg)	16.3	24.3	21.4	11.9	18.4
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Total (mg/kg)	30.2	35.5	42.0	37.7	30.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1174120-16	L1174120-17	L1174120-18	L1174120-19	L1174120-20
Description	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE
Sampled Date	25-JUN-12	25-JUN-12	25-JUN-12	26-JUN-12	26-JUN-12
Sampled Time					
Client ID	W037- REP 1	W037- REP 2	W037- REP 3	W047- REP 1	W047- REP 2
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	74.5	70.4	72.7	79.1	73.7
Metals Aluminum (Al)-Total (mg/kg)	<10	<10	<10	<10	<10
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg)	0.244	0.170	0.437	<0.050	<0.050
Barium (Ba)-Total (mg/kg)	12.4	19.0	14.0	13.1	13.8
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium (Cd)-Total (mg/kg)	<0.030	<0.030	<0.030	0.041	<0.030
Calcium (Ca)-Total (mg/kg)	3900	5100	4180	2010	1270
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Total (mg/kg)	<0.10	<0.10	<0.10	0.36	0.63
Copper (Cu)-Total (mg/kg)	3.05	3.00	2.94	4.24	2.66
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	1440	1420	1270	1540	1370
Manganese (Mn)-Total (mg/kg)	166	191	162	709	562
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	0.0058	<0.0050	<0.0050
Molybdenum (Mo)-Total (mg/kg)	0.198	0.226	0.318	0.311	0.989
Nickel (Ni)-Total (mg/kg)	1.02	0.62	0.79	2.65	1.04
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium (Sr)-Total (mg/kg)	21.1	29.9	23.4	13.2	7.42
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Total (mg/kg)	50.6	44.8	40.9	47.6	28.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1174120-21	L1174120-22	L1174120-23	L1174120-24	L1174120-25
Description	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE
Sampled Date	26-JUN-12	26-JUN-12	26-JUN-12	26-JUN-12	27-JUN-12
Sampled Time					
Client ID	W047- REP 3	W055- REP 1	W055- REP 2	W055- REP 3	W058- REP 1
Grouping / **Analyte**					
TISSUE					
Physical Tests % Moisture (%)	80.7	71.7	74.5	75.7	78.8
Metals Aluminum (Al)-Total (mg/kg)	<10	<10	<10	<10	<10
Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic (As)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Barium (Ba)-Total (mg/kg)	11.7	10.8	12.2	4.86	23.8
Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium (Cd)-Total (mg/kg)	0.038	<0.030	<0.030	<0.030	0.084
Calcium (Ca)-Total (mg/kg)	1900	1690	1420	1180	4480
Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Cobalt (Co)-Total (mg/kg)	0.45	<0.10	0.15	<0.10	0.16
Copper (Cu)-Total (mg/kg)	4.39	4.23	1.57	4.77	3.09
Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	1360	1170	1200	1390	1890
Manganese (Mn)-Total (mg/kg)	669	498	257	448	426
Mercury (Hg)-Total (mg/kg)	0.0054	<0.0050	<0.0050	0.0072	<0.0050
Molybdenum (Mo)-Total (mg/kg)	0.260	<0.050	<0.050	<0.050	0.103
Nickel (Ni)-Total (mg/kg)	2.33	1.31	0.84	1.96	1.65
Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium (Sr)-Total (mg/kg)	12.0	11.5	12.2	8.05	60.4
Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	0.038
Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Zinc (Zn)-Total (mg/kg)	42.9	36.6	33.9	34.6	44.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1174120-26 PLANT- TISSUE 27-JUN-12 W058- REP 2	L1174120-27 PLANT- TISSUE 27-JUN-12 W058- REP 3	L1174120-28 PLANT- TISSUE 27-JUN-12 W060- REP 1	L1174120-29 PLANT- TISSUE 27-JUN-12 W060- REP 2	L1174120-30 PLANT- TISSUE 27-JUN-12 W060- REP 3
Sample ID		L1174120-26	L1174120-27	L1174120-28	L1174120-29	L1174120-30
Description		PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE	PLANT- TISSUE
Sampled Date		27-JUN-12	27-JUN-12	27-JUN-12	27-JUN-12	27-JUN-12
Sampled Time						
Client ID		W058- REP 2	W058- REP 3	W060- REP 1	W060- REP 2	W060- REP 3
TISSUE						
Physical Tests	% Moisture (%)	76.6	82.7	73.2	67.3	69.9
Metals	Aluminum (Al)-Total (mg/kg)	20	<10	<10	20	<10
	Antimony (Sb)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
	Arsenic (As)-Total (mg/kg)	<0.050	<0.050	0.135	0.089	0.080
	Barium (Ba)-Total (mg/kg)	12.6	7.89	10.9	4.10	21.7
	Beryllium (Be)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
	Bismuth (Bi)-Total (mg/kg)	<0.30	<0.30	<0.30	<0.30	<0.30
	Cadmium (Cd)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	0.034
	Calcium (Ca)-Total (mg/kg)	3230	1630	3490	1910	4190
	Chromium (Cr)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Cobalt (Co)-Total (mg/kg)	0.45	0.29	0.12	<0.10	0.16
	Copper (Cu)-Total (mg/kg)	1.71	2.16	8.94	3.53	9.21
	Lead (Pb)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	1590	1620	1520	1200	1590
	Manganese (Mn)-Total (mg/kg)	401	187	879	232	1140
	Mercury (Hg)-Total (mg/kg)	0.0055	0.0051	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	0.060	<0.050	0.651	0.909	0.462
	Nickel (Ni)-Total (mg/kg)	1.36	1.70	2.72	<0.50	1.53
	Selenium (Se)-Total (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Strontium (Sr)-Total (mg/kg)	41.2	19.5	23.1	9.91	29.9
	Thallium (Tl)-Total (mg/kg)	<0.030	<0.030	<0.030	<0.030	<0.030
	Tin (Sn)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Uranium (U)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Vanadium (V)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Zinc (Zn)-Total (mg/kg)	34.9	37.5	37.6	29.6	52.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Manganese (Mn)-Total	MB-LOR	L1174120-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -3, -30, -4, -5, -6, -7, -8, -9
Method Blank	Manganese (Mn)-Total	MB-LOR	L1174120-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -3, -30, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. LORs adjusted for samples with positive hits below 5 times blank level. Please contact ALS if re-analysis is required.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-DRY-CVAFS-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry, adapted from US EPA Method 245.7. This digestion procedure was implemented on October 5, 2009.

MET-DRY-MS-VA	Tissue	Metals in Tissue by ICPMS (DRY)	EPA 200.3, EPA 6020A

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by Inductively Coupled Plasma - Mass Spectrometry, adapted from US EPA Method 6020A. This digestion procedure was implemented on October 5, 2009

MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

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CHAIN OF CUSTODY RECORD

PROJECT NAME: RJ WETLANDS

PROJECT #: 1042-008-03

FIELD SCIENTISTS AND/OR ENGINEERS: (*Print Name and Sign*)
RYAN DUNAND for WADE BRUNHAM

Laboratory Contact: AMBER SPRINGER

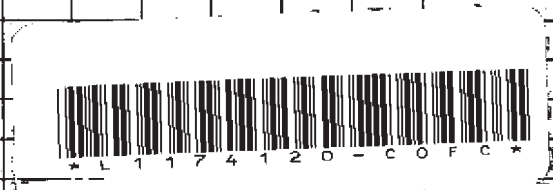
Laboratory Address: ALS BURNABY

Rescan Contact: WBRUNHAM@RESCAN.COM

STATION NUMBER	DATE	TIME	COMP. SAMPLE	GRAB SAMPLE	SAMPLE IDENTIFICATION (DEPTH, REPLICATE)	NUMBER OF CONTAINERS:	See list
1 WO05	6/21/2012				Plant	x3	
2 WO09	6/22/2012					x3	
3 WO12	6/22/2012					x3	
4 WO23	6/23/2012					x3	
5 WO25	6/24/2012					x3	
6 WO37	6/25/2012					x3	
7 WO47	6/26/2012					x3	
8 WO55	6/26/2012					x2	
9 WO58	6/27/2012					x3	
10 WO60	6/27/2012					x2	
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							

Short Holding Time
Rush Processing

L1174120



Received by:	Date/Time D/M/Y	Relinquished by:	Date/Time D/M/Y	Routine Analysis: ☑ Rush Analysis: ☐
Company:	/ /	Company:	/ /	Remarks: COURIER COPY
Name: (Print and Sign)		Name: (Print and Sign)		
Received by:	**Date/Time D/M/Y**	**Received for Laboratory by:**	**Date/Time D/M/Y**	
Company:	/ /	Company:	6 July 10:20	
Name: (Print and Sign)		Name: Brittany (Print and Sign) 17.7°C		

Appendix 6

Summary of Lichen and Plant Tissue Analytical Results on a Dry Weight Basis by LSA Sub-area and Reference Location

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Table A.6-1. Summary of Dry Weight Metal in *Cladina stygia* Tissue Samples Collected in 2012

		Detection	Mine Exploration Location (n = 11)					Exploration Road Location	Reference Location (n = 7)				
Total Metals	Units	Limit	Maximum	Minimum	Median	Mean	SD	Actual values n = 1	Maximum	Minimum	Median	Mean	SD
Aluminum (Al)	mg/kg	120.68	782.00	159.00	290.00	319.45	172.42	177.00	475.00	190.00	268.00	303.29	120.68
Antimony (Sb)	mg/kg	0.005	0.38	0.05	0.07	0.10	0.09	0.01	0.07	0.02	0.04	0.04	0.02
Arsenic (As)	mg/kg	0.083	7.88	0.58	1.45	2.24	2.28	0.08	0.49	0.23	0.38	0.37	0.11
Barium (Ba)	mg/kg	5.92	62.00	7.29	14.30	23.65	17.55	26.90	28.00	10.80	14.00	16.46	5.92
Beryllium (Be)	mg/kg	0.005	0.02	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.01
Boron (B)	mg/kg	1-2.	3.50	1.00	1.80	1.98	0.77	0.50	2.20	0.50	1.40	1.39	0.54
Cadmium (Cd)	mg/kg	0.01	0.12	0.02	0.04	0.05	0.03	0.01	0.12	0.01	0.04	0.04	0.04
Calcium (Ca)	mg/kg	6	2,890.00	857.00	1,690.00	1,642.00	596.03	366.00	1,500.00	284.00	542.00	711.86	430.80
Cesium (Cs)	mg/kg	0.005	2.23	0.06	0.11	0.37	0.64	0.39	0.97	0.04	0.06	0.20	0.34
Chromium (Cr)	mg/kg	0.05	0.44	0.18	0.27	0.29	0.07	0.18	0.52	0.16	0.23	0.28	0.12
Cobalt (Co)	mg/kg	0.02	0.30	0.12	0.18	0.19	0.06	0.51	0.34	0.10	0.15	0.17	0.08
Copper (Cu)	mg/kg	0.05	2.43	1.29	1.81	1.86	0.38	1.04	1.97	0.60	1.50	1.42	0.47
Gallium (Ga)	mg/kg	0.02	0.23	0.05	0.08	0.09	0.05	0.03	0.15	0.05	0.06	0.08	0.03
Iron (Fe)	mg/kg	1	1,210.00	281.00	396.00	497.82	268.96	101.00	654.00	259.00	299.00	384.43	145.82
Lead (Pb)	mg/kg	0.02	3.33	0.54	0.83	1.07	0.79	0.27	1.06	0.40	0.55	0.62	0.24
Magnesium (Mg)	mg/kg	10	402.00	170.00	288.00	267.82	80.69	280.00	285.00	133.00	190.00	203.43	54.33
Manganese (Mn)	mg/kg	0.02	225.00	31.60	95.50	109.70	58.04	24.80	124.00	23.10	42.50	52.70	35.42
Mercury (Hg)	mg/kg	0.005	0.07	0.02	0.04	0.04	0.01	0.01	0.06	0.01	0.02	0.03	0.01
Molybdenum (Mo)	mg/kg	0.02	0.14	0.05	0.07	0.08	0.03	0.04	0.10	0.03	0.06	0.07	0.03
Nickel (Ni)	mg/kg	0.05	1.31	0.44	0.90	0.86	0.24	2.00	1.02	0.33	0.72	0.68	0.24
Phosphorus (P)	mg/kg	40	377.00	182.00	333.00	314.36	62.31	409.00	463.00	199.00	262.00	279.71	96.05
Potassium (K)	mg/kg	200	1,030.00	500.00	760.00	740.91	175.75	1,040.00	1,280.00	490.00	640.00	728.57	268.11
Rubidium (Rb)	mg/kg	0.05	3.00	0.87	1.58	1.64	0.63	5.15	5.28	0.86	1.40	2.15	1.51
Strontium (Sr)	mg/kg	0.05	7.16	1.98	3.42	3.99	1.65	6.21	4.82	1.48	2.36	2.81	1.13
Thallium (Tl)	mg/kg	0.002	0.03	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.00
Thorium (Th)	mg/kg	0.01	0.07	0.01	0.03	0.03	0.02	0.01	0.04	0.01	0.02	0.02	0.01
Tin (Sn)	mg/kg	0.02	0.07	0.02	0.03	0.03	0.02	0.01	0.02	0.01	0.02	0.02	0.01
Titanium (Ti)	mg/kg	0.05	29.80	6.31	13.80	15.51	6.70	2.44	31.70	5.17	11.40	13.83	9.31
Uranium (U)	mg/kg	0.002	0.02	0.01	0.01	0.01	0.00	0.00	0.02	0.00	0.01	0.01	0.00
Vanadium (V)	mg/kg	0.02	1.79	0.52	0.84	0.89	0.34	0.21	1.74	0.54	0.71	0.86	0.42
Yttrium (Y)	mg/kg	0.01	0.23	0.08	0.14	0.16	0.05	0.05	0.22	0.08	0.11	0.13	0.05
Zinc (Zn)	mg/kg	0.5	20.00	5.78	11.70	11.85	4.60	11.30	20.50	5.78	8.92	10.89	5.06

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: rhenium, sodium and tellurium.

Parameters with more than 50% of samples below detection limit: bismuth, lithium, selenium and zirconium.

Table A.6-2. Summary of Dry Weight Metal in *Ster* sp. Tissue Samples Collected in 2012

		Detection	Transmission Line Location (n =2)					Exploration Road Location
Total Metals	Units	Limit	Maximum	Minimum	Median	Mean	SD	Actual Values n = 1
Aluminum (Al)	mg/kg	120.68	793.00	281.00	537.00	537.00	362.04	147.00
Antimony (Sb)	mg/kg	0.005	0.03	0.03	0.03	0.03	0.00	0.02
Arsenic (As)	mg/kg	0.083	0.46	0.39	0.42	0.42	0.05	0.28
Barium (Ba)	mg/kg	5.92	21.60	13.80	17.70	17.70	5.52	6.52
Beryllium (Be)	mg/kg	0.005	0.04	0.02	0.03	0.03	0.01	0.01
Boron (B)	mg/kg	1-2.	1.90	0.50	1.20	1.20	0.99	1.60
Cadmium (Cd)	mg/kg	0.01	0.12	0.07	0.09	0.09	0.03	0.09
Calcium (Ca)	mg/kg	6	2,750.00	559.00	1,654.50	1,654.50	1,549.27	3,910.00
Cesium (Cs)	mg/kg	0.005	0.28	0.12	0.20	0.20	0.11	0.09
Chromium (Cr)	mg/kg	0.05	0.42	0.40	0.41	0.41	0.01	0.26
Cobalt (Co)	mg/kg	0.02	0.32	0.21	0.27	0.27	0.07	0.15
Copper (Cu)	mg/kg	0.05	6.09	3.38	4.74	4.74	1.92	2.19
Gallium (Ga)	mg/kg	0.02	0.08	0.06	0.07	0.07	0.01	0.04
Iron (Fe)	mg/kg	1	496.00	381.00	438.50	438.50	81.32	230.00
Lead (Pb)	mg/kg	0.02	0.52	0.39	0.46	0.46	0.09	0.45
Magnesium (Mg)	mg/kg	10	323.00	247.00	285.00	285.00	53.74	228.00
Manganese (Mn)	mg/kg	0.02	46.10	18.40	32.25	32.25	19.59	13.30
Mercury (Hg)	mg/kg	0.005	0.03	0.03	0.03	0.03	0.00	0.02
Molybdenum (Mo)	mg/kg	0.02	0.24	0.14	0.19	0.19	0.07	0.21
Nickel (Ni)	mg/kg	0.05	3.94	2.68	3.31	3.31	0.89	1.10
Phosphorus (P)	mg/kg	40	742.00	578.00	660.00	660.00	115.97	579.00
Potassium (K)	mg/kg	200	2,310.00	1,700.00	2,005.00	2,005.00	431.34	1,820.00
Rubidium (Rb)	mg/kg	0.05	9.23	3.61	6.42	6.42	3.97	2.41
Strontium (Sr)	mg/kg	0.05	21.20	3.13	12.17	12.17	12.78	8.09
Thallium (Tl)	mg/kg	0.002	0.01	0.01	0.01	0.01	0.00	0.01
Thorium (Th)	mg/kg	0.01	0.02	0.02	0.02	0.02	0.00	0.01
Tin (Sn)	mg/kg	0.02	0.01	0.01	0.01	0.01	0.00	0.03
Titanium (Ti)	mg/kg	0.05	16.80	16.10	16.45	16.45	0.49	10.00
Uranium (U)	mg/kg	0.002	0.01	0.01	0.01	0.01	0.00	0.01
Vanadium (V)	mg/kg	0.02	0.89	0.82	0.86	0.86	0.05	0.50
Yttrium (Y)	mg/kg	0.01	0.44	0.35	0.40	0.40	0.07	0.09
Zinc (Zn)	mg/kg	0.5	22.10	19.40	20.75	20.75	1.91	18.20

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: rhenium, sodium and tellurium.

Parameters with more than 50% of samples below detection limit: bismuth, lithium, selenium and zirconium.

Table A.6-3. Summary of Dry Weight Metal in *V. ovalifolium* Tissue Samples Collected in 2012

Total Metals	Units	Detection Limit	Exploration Road Location (n = 10)					Transmission Line Location
			Maximum	Minimum	Median	Mean	SD	Actual Values n = 1
Aluminum (Al)	mg/kg	10	62.00	13.00	22.50	27.10	14.74	5.00
Barium (Ba)	mg/kg	0.05	23.80	7.41	13.65	14.28	5.26	4.76
Calcium (Ca)	mg/kg	10	1,730.00	848.00	1,255.00	1,266.80	261.08	2,220.00
Copper (Cu)	mg/kg	0.05	8.78	2.36	5.04	5.36	1.73	4.41
Iron (Fe)	mg/kg	1	51.00	13.00	18.50	24.05	12.37	23.00
Magnesium (Mg)	mg/kg	3	825.00	511.00	628.00	649.20	96.24	517.00
Manganese (Mn)	mg/kg	0.05	397.00	139.00	246.50	257.80	88.89	19.00
Molybdenum (Mo)	mg/kg	0.05	1.70	0.06	0.26	0.39	0.48	0.37
Nickel (Ni)	mg/kg	0.5	1.16	0.25	0.76	0.74	0.32	0.69
Phosphorus (P)	mg/kg	20-200	2,350.00	970.00	1,455.00	1,567.00	453.63	1,470.00
Potassium (K)	mg/kg	100-1,000	10,300.00	5,500.00	6,650.00	7,265.00	1,729.81	6,500.00
Strontium (Sr)	mg/kg	0.05	9.38	1.45	2.80	3.92	2.51	4.64
Tin (Sn)	mg/kg	0.2	1.67	0.10	1.06	0.96	0.51	1.31
Zinc (Zn)	mg/kg	0.5	11.30	4.28	7.60	8.11	2.15	8.92

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: antimony, arsenic, beryllium, bismuth, chromium,cobalt, lithium, selenium, sodium, thallium, uranium and vanadium.

Parameters with more than 50% of samples below detection limit: cadmium,lead, mercury, titanium.

Table A.6-4. Summary of Dry Weight Metal in *V. membranaceum* Tissue Samples Collected in 2012

Total Metals	Units	Detection Limit	Exploration Road Location (n = 9)					Transmission Line Location (n = 2)				
			Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD
Aluminum (Al)	mg/kg	10	39.00	22.00	33.00	31.11	5.46	49.00	32.00	40.50	40.50	12.02
Barium (Ba)	mg/kg	0.05	25.90	8.94	15.20	15.24	5.40	38.10	18.00	28.05	28.05	14.21
Calcium (Ca)	mg/kg	10	5,060.00	866.00	1,230.00	1,599.67	1,318.92	2,380.00	1,550.00	1,965.00	1,965.00	586.90
Copper (Cu)	mg/kg	0.05	6.48	2.96	3.92	4.46	1.20	6.35	5.35	5.85	5.85	0.71
Iron (Fe)	mg/kg	1	27.00	12.50	18.00	18.04	5.02	26.00	21.00	23.50	23.50	3.54
Magnesium (Mg)	mg/kg	3	730.00	478.00	555.00	589.67	94.53	775.00	675.00	725.00	725.00	70.71
Manganese (Mn)	mg/kg	0.05	450.00	109.00	170.00	218.67	106.79	274.00	171.00	222.50	222.50	72.83
Molybdenum (Mo)	mg/kg	0.05	0.42	0.06	0.16	0.18	0.14	0.11	0.05	0.08	0.08	0.05
Nickel (Ni)	mg/kg	0.5	1.45	0.25	0.67	0.75	0.35	2.36	0.76	1.56	1.56	1.13
Phosphorus (P)	mg/kg	20-200	1,830.00	1,130.00	1,300.00	1,322.22	220.67	2,000.00	1,630.00	1,815.00	1,815.00	261.63
Potassium (K)	mg/kg	100-1000	7,100.00	4,700.00	5,800.00	5,711.11	750.26	7,300.00	6,000.00	6,650.00	6,650.00	919.24
Strontium (Sr)	mg/kg	0.05	11.00	1.80	2.97	4.13	2.82	8.22	6.92	7.57	7.57	0.92
Tin (Sn)	mg/kg	0.2	2.74	0.10	0.87	0.98	0.85	1.25	1.03	1.14	1.14	0.16
Zinc (Zn)	mg/kg	0.5	15.30	5.01	7.50	7.96	3.00	12.20	8.40	10.30	10.30	2.69

Notes:

Only parameters with concentrations above detection limits in more than 50% of the samples listed.

Parameters with concentration of all samples below the detection limit: antimony, arsenic, beryllium, bismuth, chromium,cobalt, lithium, selenium, sodium, thallium, uranium and vanadium.

Parameters with more than 50% of samples below detection limit: cadmium,lead, mercury, titanium.