APPENDIX 9-A

Ecosystems, Vegetation, Terrain, and Soils Baseline Report

Red Mountain Underground Gold Project
Ecosystems, Vegetation and Soils Baseline Report

Date: June 16, 2017

PRESENTED TO:

IDM

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GLOSSARY AND ABBREVIATIONS

Term	**Definition**
AIR	Application Information Requirements
Application	Application for an Environmental Assessment Certificate
BAT	Best Available Technology
BEC	Biogeoclimatic Ecosystem Classification
BC CDC	British Columbia Conservation Data Centre
BCEAA	British Columbia Environmental Assessment Act
BMPs	Best Management Practices
CCME	Canadian Council of Ministers of the Environment
CEA	Canadian Environmental Assessment
CEC	Cation exchange capacity
CEAA	Canadian Environmental Assessment Act
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSSC	Canadian System of Soil Classification
EAO	Environmental Assessment Office
EMA	*Environmental Management Act*
IC	Intermediate Components
IDM	IDM Mining Ltd.
kV	kilovolt
LSA	Local Study Area
Ma	Million annum
masl	metres above sea level
mtpa	metric tonnes per annum
ML/ARD	Metal leaching/acid rock drainage

MOE	Ministry of Environment
NLG	Nisga'a Lisims Government
PEM	Predictive Ecosystem Mapping
PFSA	Project Footprint Study Area
RSA	Regional Study Area
SAGA	System for Automated GeoScientific Analyses
SARA	*Species at Risk Act*
SEP	Soil erosion potential
SMR	Soil moisture regime
SMU	Soil map unit
SNR	Soil nutrient regime
TEM	Terrestrial Ecosystem Mapping
TMF	Tailings Management Facility

1. INTRODUCTION

Terrestrial baseline studies to support an environmental assessment of the Red Mountain Underground Gold Project (the Project) were undertaken by EcoLogic Consultants Ltd. (EcoLogic) in 2016 and 2017. The studies included terrain, ecosystem, and soils mapping. Field studies included ground-truthing the mapping products, rare plant and lichen surveys, invasive plant surveys, and soil sampling for metals analysis. 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.

The goals of these studies were to characterize vegetation, ecosystems, terrain, and soils that may be affected directly or indirectly by the Project at local and regional levels. These baseline data will also be used as base layers for other disciplines' studies of other aspects of the Project, to develop management and mitigation plans, and to guide the reclamation and closure plan.

The main objectives of the terrestrial ecosystems baseline studies included:

- map and characterize ecosystems in the Regional Study Area (RSA);
- map and characterize ecosystems in the Local Study Area (LSA);
- map and characterize ecosystems in the Project Footprint Study Area (PFSA);
- identify plant and lichen species present in the LSA, including invasive plant species, and those species tracked by the BC CDC, assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), protected under the *Species At Risk Act*, or otherwise considered rare or of conservation interest; and
- provide sufficient information to develop the effects assessment, management and mitigation plans, and the reclamation and closure plan.

The main objective of the terrain and soils baseline studies included:

- map and characterize terrain (surficial geology), geohazards, terrain stability, and soil erosion potential for the Project PFSA;
- characterize soils within the PFSA;
- characterize soil salvage potential within the PFSA; and
- characterize baseline metals concentrations in the PFSA.

The scope of this assignment did not include determination of magnitude, frequency, and/or consequence of the natural hazards or snow avalanches, and thus it is not a Geohazard Risk Assessment. The natural hazards mapped in this assignment are those which are currently inferred to exist based on the visual evidence from air photos. Knowledge of where existing natural hazards and potentially unstable terrain are located provides direction to focus subsequent terrain stability assessments and analyses of risk of natural hazards present in the area.

2. PROJECT DESCRIPTION

IDM Mining Ltd. (IDM) proposes to develop and operate the Project, an underground gold mine in the Bitter Creek Valley on a contiguous group of mineral tenures known collectively as the Red Mountain property, located near Stewart, in northwest British Columbia (Figure 2-1). The Project will extract high-grade gold and silver ore to be processed on site.

The Project is composed of two main areas with interconnecting access roads:

- Mine Site with an underground mine and dual portal access at the upper elevations of Red Mountain (1,950 metres above sea level [masl]); and
- Bromley Humps, situated in the Bitter Creek Valley (500 masl), where the Process Plant and tailings management facility (TMF) will be located.

Red Mountain Underground Gold Project

Location of the Proposed Project

Figure 2-1

Date: 6/1/2017
Map Number: RM-043
Coordinate System: NAD 1983 BC Environment Albers
Projection: Albers
Datum: North American 1983

Legend

- Red Mountain
- City/Town
- Highway

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3. BACKGROUND INFORMATION

3.1 REGIONAL SETTING

The Project is roughly split between the Boundary Ranges and Nass Ranges Ecoregions (Figure 3.1-1). Ecoregions are areas that contain major physiographic and minor macroclimatic or oceanographic variation. The 47 Ecoregions that occur in British Columbia are further divided into 139 Ecosections, based on minor physiographic, oceanic, and macroclimatic variation (Demarchi, 1996). The Project is located in the Boundary Ranges of the Coast Mountain Physiographic Region (Holland, 1976)

The Boundary Ranges Ecoregion is characterized by rugged granitic and metamorphic-based mountains that are largely ice-capped. Within the Boundary Ranges, the western half of the Project is situated within the Southern Boundary Ranges Ecosection. The Southern Boundary Ranges consists of wet, rugged mountains that contain frequent remnant icefields and glaciers. Numerous rivers dissect the mountains, including Bear River, which drains into Portland Canal (Pacific Ocean) at the town of Stewart. Precipitation rates from moist Pacific Ocean air are high, resulting in a landscape that is dominated by low elevation wet Coastal Western Hemlock (CWH) forests, with wet Mountain Hemlock (MH) forest on the mid- to upper-slopes, followed by a transitional MH subalpine forest above. Just east of Bear Glacier, MH forests transition into the wet, cold Interior Cedar–Hemlock (ICH) forests that dominate the lower elevations of the Meziadin Mountains Ecosection to the east. Valley bottom areas along Bear River contain extensive cottonwood floodplain forests interspersed with swamp and marsh wetlands. Alpine areas are extensive, sparsely vegetated, and contain large expanses of ice such as the Cambria Ice Field (Demarchi, 1996).

The Nass Ranges Ecoregion occurs to the east, with roughly half of the Project occurring in the Meziadin Mountains Ecosection, along with a small portion of the Nass Basin Ecosection to the southeast. The Nass Ranges is a transitional area from coast to interior, with western portions containing rugged, wet mountains similar to the Boundary Ranges, while eastern mountains are more subdued. The Meziadin Mountains Ecosection is comprised of rugged, granitic mountains that are located on the leeward side of the Boundary Ranges. White River and numerous small drainages flow east into Meziadin Lake and Meziadin River. The east-facing slopes of the Meziadin Mountains Ecosection contain the leeward variant of wet MH forests, with transitional MH subalpine forest above. Lower slopes and valley bottoms contain wet, cold ICH forests. Alpine areas make up a large portion of the Meziadin Mountains Ecosection, and range from large expanses of ice fields, multiple glaciers, and a variety of vegetated and sparsely vegetated areas (Demarchi, 1996).

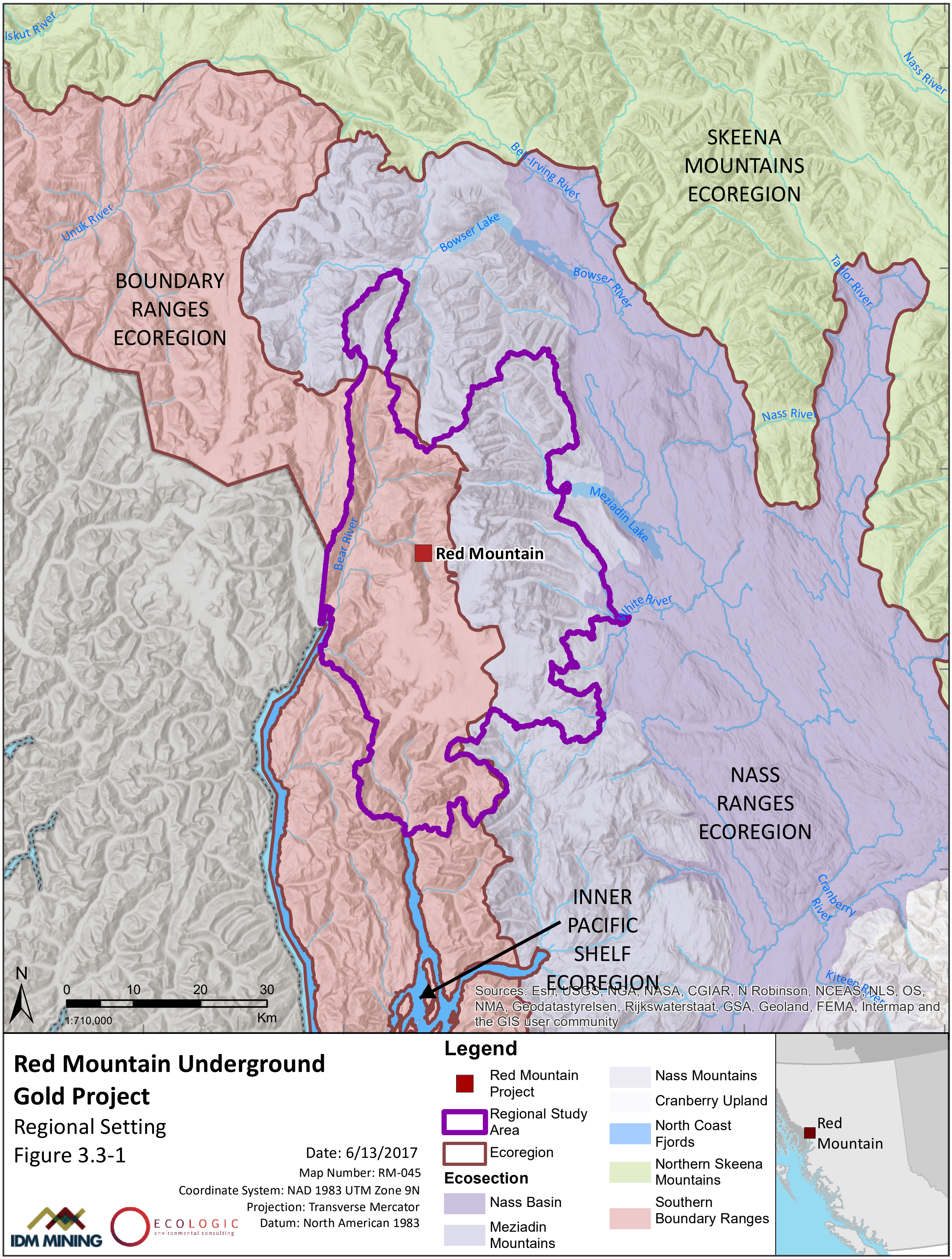
3.2 LOCAL SETTING

The Bitter Creek watershed is located within the Southern Boundary Ranges and contains the proposed Project infrastructure. The watershed is a largely north-south oriented valley that drains Bromley Glacier into Bear River. Roosevelt Creek is a significant drainage occupying a hanging valley in the northeast portion of the watershed, while smaller watercourses frequently occur in deep gullies on the steep mountain slopes. The area is characterized by steep, wet slopes that contain frequent avalanche tracks and mass wasting event that arise in oversteepened glacial deposits. The north end of Bitter Creek Valley contains CWH forests along the lower- and mid-slopes, including large areas of mid-slope mature and old forests. The mouth of Bitter Creek, as it drains into Bear River, is characterized by flat floodplain forests, dominated by deciduous stands adjacent to the rivers and grading into mixed forests on higher, less active floodplains. Narrow fringes of floodplain forest extend up Bitter Creek, although most of the active creek floodplain is highly scoured rock and gravel, interspersed with sparsely vegetated areas. MH forests occupy a narrow, steep band above the CWH (around 700 masl), and replace the CWH at the valley bottom as elevation increases to the southeast of Roosevelt Creek.

As Bitter Creek climbs in elevation towards Bromley Glacier, lower slope forests begin to be replaced by early seral shrub communities where the soil development is limited and vegetation communities are in early stages of post-glaciation establishment. At the southern end of the valley the MH transitions into sparse parkland communities, with the majority of the area dominated by recently de-glaciated morainal deposits, along with colluvial slopes and barren alpine communities. Parkland MH forests start around 900 masl, and often contain very old forested stands before giving way to stunted Krummholz around 1,200 masl as the alpine zone begins. Alpine communities are varied in the Bitter Creek Watershed; transitional areas above the parkland forests are often diverse and contain rich herb meadow slopes, while other areas contain subalpine fir (*Abies lasiocarpa*) Krummholz, and expanses of alpine heath intermixed with dwarf shrub tundra-like communities. Exposed higher elevations contain extensive sparsely vegetated communities in alpine fellfields and barren rock outcrops before yielding to glaciers and icefields.

Avalanche tracks are abundant in the watershed, due to steep slopes and high snowfall. Avalanche track communities are typically wet and rich and dominated by alder (*Alnus viridis* ssp. *crispa*), with lesser components of Devil's club (*Oplopanax horridus*) and various willows (Salix spp.). At upper elevations the avalanche slopes contain lush herb meadows. The edge of avalanche tracks, as they pass through forested areas, often contain slide-maintained forested communities that are irregular and fragmented in extent, and contain abundant dead or damaged trees.

Resource activity is historically common in the Bitter Creek watershed. Highway 37A and a BC Hydro powerline cross the creek near the confluence with Bear River. Much of the area near Highway 37A has been, or is being, cleared or logged for various purposes. Small quarries and borrow pits associated with the highway or powerline construction occur along Highway 37A, and basic amenities have been developed for a recreation area at Clements Lake. An old, overgrown road runs parallel to much of Bitter Creek along the northern side on old floodplains and the toe of the slope. Several smaller old roads branch off up the slopes, and there are numerous old logged areas adjacent to the road. Additional roads occur around the vicinity of the old mine portal on Red Mountain. Mining exploration has occurred in the past. Current exploration activities include new roads in the alpine near the old portal, along with the exploration camp, helicopter pad, and numerous temporary drill pads.



Red Mountain Underground Gold Project

Regional Setting

Figure 3.3-1

Date: 6/13/2017

Map Number: RM-045

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

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3.3 Geology

The Bitter Creek Watershed is adjacent to the boundary of Intermontane and Coast belts of the Canadian Cordillera, along the southwest margin of the Bowser Basin and the western border of the Stikine Terrace. There are three primary stratigraphic elements in the Stikinia terrane and all are present in the Stewart area: Middle and Upper Triassic clastic rocks of the Stuhini Group, Lower and Middle Jurassic volcanic and clastic rocks of the Hazelton Group, and Upper Jurassic sedimentary rocks of the Bowser Lake Group. More specifically, there are well-bedded Jurassic marine clastic rocks of the Hazelton Group (ca. 157 to 174 Ma), overly massive and competent Paleozoic to Lower Jurassic (ca. 174-201 Ma), and oceanic arc, volcanic and volcanoclastic basement rocks (Greig et al., 1994). These structures are exposed by Late Jurassic (ca. 157 Ma) and Early Cretaceous to Tertiary (ca. 147-165 Ma) structural folding within the Skeena Fold Belt, which are in turn intruded by Eocene and older (ca. 35-56 Ma) granite, granodiorite and diorite intrusions of the Coast Plutonic Complex (Metcalfe, 2013). Much of the area has undergone metamorphic mineralization, associated with the arrival of island arc assemblages, which resulted in four significant magmatic episodes. Each of these episodes had duration of 5 to 10 Ma and are collectively identified as the Red Mountain (Goldslide) Stock (Greig et al., 1994).

The Eocene (35-56 Ma) Coast Plutonic Complex dominates the northwestern third of the Bitter Creek Watershed. Moving up past Roosevelt Creek, which enters Bitter Creek from the north, the rock formations change to the Middle to Upper Jurassic Hazelton Group Undivided Sedimentary rocks. These formations then transition to Early Jurassic to Triassic (174-251 Ma) Hazelton Group–Unuk River Formation andesitic volcanic rocks. The Early Jurassic (174-201) Red Mountain (Goldslide) dioritic intrusive complex forms the area of exploration, and contains the location of the Red Mountain Gold Mine Project.

As outlined in SRK Consulting Ltd. (2017), drill hole and outcrop samples collected and analyzed for the Project have been used to produce mine-scale geological mapping from 12.7 km along the existing road to the existing portal at Red Mountain. The results of drilling in the Bromley Humps area reveal that the narrow band of hummocky bedrock along the Bitter Creek valley bottom, between about 12 km on the existing road and Goldslide Creek, consists of intrusive bedrock, including, gabbro, diorite, Goldslide porphyry, dikes and mafic dikes.

3.4 Landscape Evolution

The BC Cordillera was glaciated repeatedly during quaternary period (2.6 million years ago to 11,700 years ago). The most recent of these glaciations, known as the Fraser Glaciation, commenced about 29,000 years before present. During this time, ice accumulated in cirques at high elevations. These gradually expanded and merged until the valleys were filled and all but the highest mountain peaks were covered. About 17,000 years ago, when the ice sheet was thickest and most extensive in the area, the ice sheet flowed generally from north to south across the region (Ferbey et al, 2013).

Deglaciation commenced about 15,000 years ago. Deglaciation took place by downwasting (i.e., thinning of the glacial ice due to melt) so that the uplands emerged from ice first while tongues of ice remained in the valley bottoms. Downwasting ice often forms characteristic subglacial and ice-marginal landforms on gentler surfaces, such as kames[1] and ice-dammed lakes.

During the post-glacial period known as the Holocene Epoch, there were episodic advances and retreats of valley and alpine glaciers within many valleys of the Coast Mountains (Menounos, et al, 2009). The most extensive of these re-advances occurred during the Little Ice Age which commenced during the 12th century, reached a maximum between the 17th and 19th century and has undergone rapid melt since (Menounos 2009). In the Bitter Creek valley, the Bromley Glacier deposited thick lateral moraines along the mid and lower slopes during the Little Ice Age. Natural processes, such as landslides and stream erosion, have re-worked some glacial sediments to redistribute them as colluvium and fluvial sediments. Streams and rivers have graded to the present-day river level of the Bear River, downcutting into glacial deposits and bedrock creating terraces, benches, and steep-sided scarps. A series of glaciofluvial terraces and raised alluvial fans are located along the lower slopes of the Study Area. Alluvial fans have formed at the mouths of the major creeks. Colluvium is present on many of the steep slopes in the Study Area. Buried glaciolacustrine sediments were found in the valley bottom of the PFSA in the vicinity of Radio and Roosevelt Creeks and downstream Hartley Creek.

3.5 APPLICABLE LEGISLATION (FEDERAL AND PROVINCIAL)

3.5.1 Legislation and Best Management Practices for Terrestrial Ecosystems and Vegetation

Mine development is subject to federal and provincial legislation, guidelines, and best management practices for the management of terrestrial ecosystems and vegetation.

Federal legislation includes:

- *Species at Risk Act (SARA; "Species at Risk Act," 2002);*
- *Fisheries Act* ("Fisheries Act," 1985); and
- *Migratory Birds Convention Act* (MBCA; 1994).

Provincial legislation includes:

- *Mines Act* (1996);
- *Forest and Range Practices Act* ("Forest and Range Practices Act," 2002);
- *Weed Control Act* ("Weed Control Act," 1996);

[1] Gravel deposits from meltwater rivers flowing along ice margins.

- *Wildlife Act* ("Wildlife Act," 1996);
- *Environmental Management Act* (2003);
- *Riparian Areas Protection Act* (2016); and
- The *Mines Act* (2017) Health, Safety and Reclamation Code.

The purpose of the SARA is to protect species from becoming extirpated or extinct and to assist in the recovery of species that are threatened, endangered, or extirpated due to human activity. Section 32(1) states that, “No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species.” Although the SARA does not include broad habitat protection provisions (i.e., largely limited to those species with defined ‘critical habitat’), the loss or alteration of habitat of SARA-listed species has been interpreted as “harm” under the act.

Section 35 of the *Fisheries Act* establishes rules for authorized works or undertakings that could adversely affect fish. Section 36 regulates deposition of deleterious substances in places where they could enter waters frequented by fish. Recent amendments to the *Fisheries Act* (i.e., in 2012) largely removed its habitat protection functions. Current prohibitions within the amended Act focus on preventing “serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.”

The MBCA prohibits activities that may result in “the killing, capturing, injuring, taking or destroying of migratory birds or the damaging, destroying, removing or disturbing of nests” (e.g., land clearing and vegetation management activities during the breeding bird window).

The BC *Mines Act* requires mine proponents to complete Terrestrial Ecosystem Mapping (TEM) of a proposed mine site as part of the mine permit application. The permit application also requires vegetation metals analyses, including a baseline inventory of possible biological (including human) receptors.

The *Forest and Range Practices Act* regulates forestry activities such as logging, road building, reforestation, and riparian area management. The act requires that forestry and range development be conducted in accordance with rules and regulations to ensure the protection of the environment. The *Forest and Range Practices Act*, through the Identified Wildlife Management Strategy 2004, outlines procedures for establishing and modifying wildlife habitat areas.

The *Weed Control Act* regulates the management of noxious weeds in BC; the act requires that owners or occupiers of land control the establishment and prevent dispersal of noxious weeds.

The provincial *Wildlife Act* provides for protection of specific ecosystems and ecosystem components that provide habitat for threatened species.

The *Environmental Management Act* (EMA) 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.

The *Fish Protection Act* was re-titled the *Riparian Areas Protection Act* in 2016; this act regulates local government approvals of work in and around watercourses. The regulations focus on protection of riparian features necessary to maintain stream health, and prohibit the introduction of debris into streams, stream channels, or areas adjacent to streams.

The Health, Safety and Reclamation Code for Mines in British Columbia is part of the BC *Mines Act*. The code requires that mining and exploration activities in watersheds and riparian areas adhere to standards and are subject to regular inspections. Specific guidelines are provided for community watersheds, riparian management, soil conservation, and terrain management.

3.5.2 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) requires that proponents provide:

- information on surficial geology, terrain mapping, soil survey and characterization (including soil metals), vegetation, wildlife, land capability, and present land use;
- plans for salvaging and stockpiling of surface soils and overburden materials (Chapter 29.25: Terrain and Soil Management Plan);
- an erosion and sediment control plan; and
- a reclamation plan.

The Fish Habitat Protection and Pollution Prevention provisions of the *Fisheries Act* regulate discharge of harmful substances, including sediment, into fish habitat (s. 34) and describe measures required to avoid or minimize effects on the aquatic environment, shoreline, and riparian areas during development and operation of a project (s. 37). Consideration of the above legislation is particularly important in cases when project development is located near shorelines or riparian areas where sediment and chemical contaminants could migrate into the aquatic environment.

The EMA establishes criteria under which sediment yield is considered a pollutant. BC's water quality guidelines recommend targets for acceptable sediment levels (turbidity and suspended and benthic sediments); these are used to determine performance of control measures while undertaking in-stream works (BC MOE 2003).

Unpaved roads can contribute significantly to soil erosion; adverse effects can be mitigated through use of best management practices (BMPs) that focus on erosion prevention and watercourse sedimentation resulting from accelerated soil erosion. The *Forest and Range Practices Act* governs road construction and maintenance within provincial forests, and requires that these activities be carried out in accordance with the codes provided in the Forest Service Road Use Regulation (BC Reg. 70/2004). Guidance for development of roads (road design and field practices) is provided in the Forest Road Engineering Guidebook (BC MOF 2002).

The Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CCME 2007) provide guidelines for contaminants in soil. These Canada-wide guidelines suggest maximum limits for substances such as pesticides, metals, and hydrocarbons in soil and apply to residential, agricultural, industrial, and other land uses. The Contaminated Sites Regulation (BC Reg. 375/96) is part of the EMA and lists criteria for toxicity to soil invertebrates and plants. These criteria are used to define if a specific site is contaminated, to determine liability for site remediation, and to assess the effectiveness of remediation and reclamation efforts.

Terrain (surficial geology), terrain stability and soil erosion potential (SEP) mapping followed current Provincial standards and guidelines, including:

- The Terrain Mapping Classification System for British Columbia (Howes and Kenk, 1997);
- The Guidelines and Standards for Terrain Mapping in British Columbia (R.I.C., 1996);
- The Mapping and Assessing Terrain Stability Guidebook (B.C. Ministry of Forests, 1999).
- Standard for Terrestrial Ecosystem Mapping in British Columbia (R.I.C., 1998), and
- Terrestrial Ecosystem Information Digital Data Submission Standard – Draft for Field Testing B.C. Ministry of Environment, 2010).

4. STUDY AREA

4.1 Regional Study Area

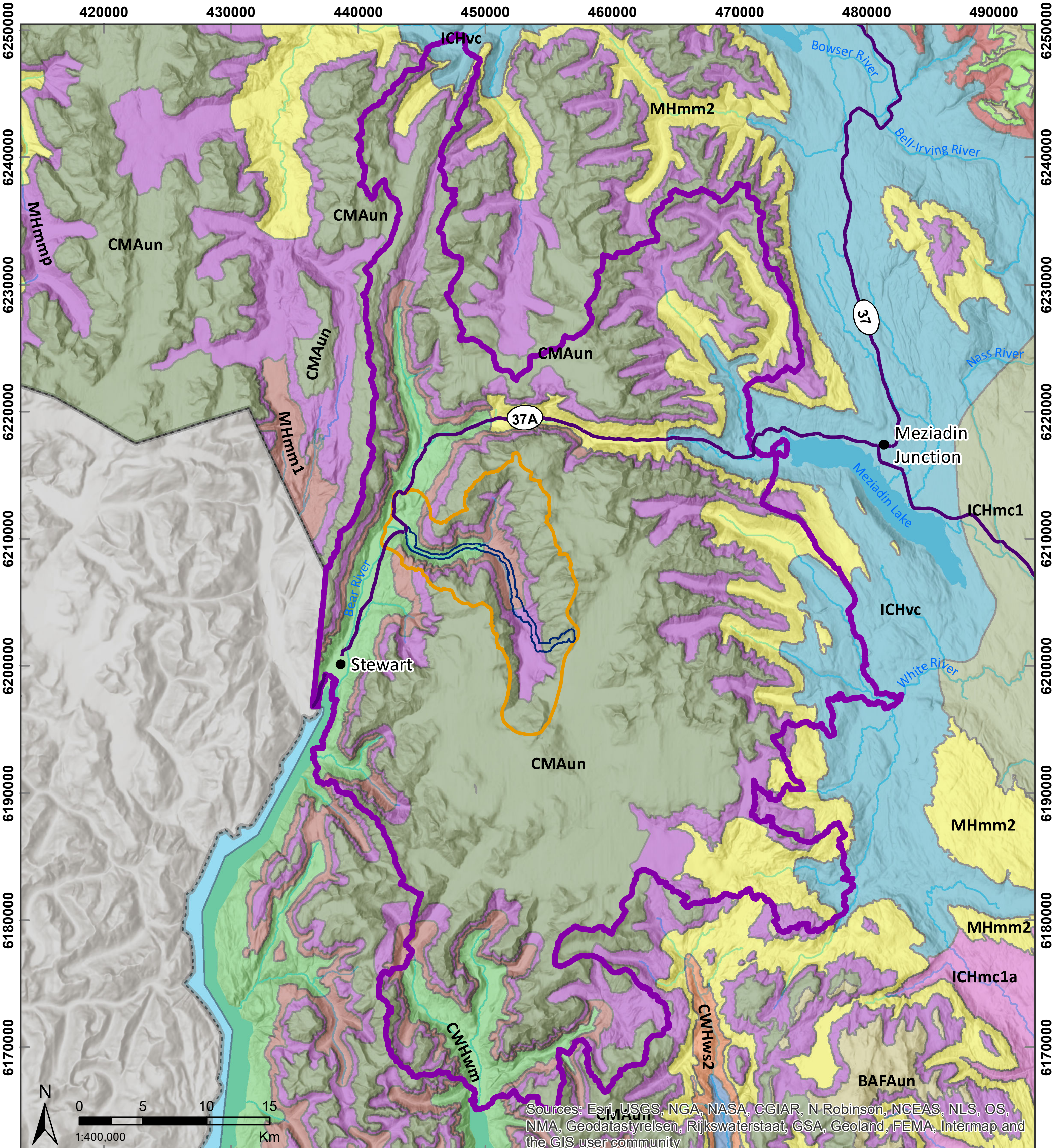
The Regional Study Area (RSA) is the spatial area that encapsulates the Project and extends beyond to the height of land to include several watersheds within the region (Figure 4.1-1). The RSA boundary takes into consideration the predicted habitat of select wildlife over a season or a lifetime or both, such as grizzly bears and mountain goats. The RSA boundary provides context for the type, distribution, extent, and prevalence of ecosystems within the region. The RSA is 211,570 hectares in size.

4.2 Local Study Area

The Local Study Area (LSA) was established to provide a study area boundary for assessing the effects of the Project at the local watershed level. The LSA encompasses the full extent of the Bitter Creek watershed. It extends to the height of land on all sides of Bitter Creek, including the Roosevelt Creek drainage, and a portion of Bromley Glacier to the south. The northwest end of the LSA includes the mouth of Bitter Creek where it passes Highway 37A and drains into Bear River, including an area of floodplain forest and Clements Lake. The LSA is 15,860 hectares in size.

4.3 Project Footprint Study Area

The Project Footprint Study Area (PFSA) was created to assess the direct and indirect effects of the Project on vegetation ecosystems, terrain and soils. It was created at the Project infrastructure level where effects on terrestrial ecology and vegetation could be assessed for each Project component. The PFSA includes a 150-m buffer around all Project components for a total area of 961 hectares.



Red Mountain Underground Gold Project

Regional, Local and Project Footprint Study Areas for the Project

Figure 4.4-1

Date: 6/13/2017

Map Number: RM-034

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

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Legend

- Community
- Highway
- Project Footprint Study Area
- Local Study Area
- Regional Study Area

BEC Zone

- CMAun
- CWHwm
- MHmm1
- MHmm2
- MHmmp
- ICHvc
- BAFAun
- CWHws1
- CWHws2
- ESSFun
- ESSFunp
- ICHmc1
- ICHmc1a

5. METHODOLOGY

5.1 FIELD SAMPLING

To support mapping and baseline characterization of the terrain, soils, invasive plants and ecosystems, EcoLogic soil scientists and ecologists collected site information including detailed site, soils, and vegetation information according to the guidelines established in the Field Manual for Describing Terrestrial Ecosystems 2nd Edition (BC Min. of Forests and Range and BC Min. of Env., 2010). Field sampling was completed in the RSA, LSA and PFSA with the purpose of characterizing a representative sample of the full range of ecosystems that occur in the BEC units.

Site information was collected using a combination of FS882 full plots, Site Visit Form (SIVI), and visual observations. Soils were classified per the Canadian System of Soil Classification (Soil Classification Working Group, 1998). Ecosystems were classified according to the Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia (MacKenzie, 2012); the Wetlands of British Columbia: a guide to identification (MacKenzie and Moran, 2004); and a Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region (Banner et al., 1993).

Field surveys were conducted by four qualified professionals (two ecologists, a soil scientist and a botanist) and two Nisg̱a'a assistants, from July 4th to 11th, 2016. Surveys to confirm preliminary TEM, PEM and terrain mapping included the completion of 21 detailed ecosystem (FS882) plots, 23 site visit (SIVI) plots, 31 custom SIVI data forms collected digitally on an iPad, and 81 visual inspections (Figure 5.1-1). At a minimum, visual field data included the ecosystem classification, terrain classification, and vegetation structural stage attributes. In addition, 146 digital SIVI plots and over 500 visual observations (mainly from a helicopter) were made throughout the LSA and RSA. These visual observations were completed to support terrain and ecosystem and the PEM modelling, and ranged from descriptions of leading vegetation and structural stage, slope and terrain comments, and where obvious ecosystem classification. Appendix A contains a summary of the field sample data for the FS882 and SIVI plots.

Overall, sampling achieved a Survey Intensity Level (SIL) 3 for both the PFSA and the LSA. SIL 3 generally supports mapping in the 1:10,000 range. This is appropriate mapping intensity level for effects assessment type applications.

5.2 TERRAIN, TERRAIN STABILITY AND BIOTERRAIN MAPPING

For the LSA, Terrain and terrain stability mapping was completed at 1:20,000 scale by SNC Lavalin. For more details regarding the methods and results for the LSA terrain stability mapping, please refer to SNC Lavalin (2017).

This section outlines the methods used to complete terrain, terrain stability and soil erosion potential mapping of the PFSA at 1:5,000 scale. The background information reviewed to complete this work included:

- Cui., Y et al (2015). British Columbia digital geology;
- Greig, C.J. et al. (1994). Geology of the Cambria Icefield;
- SNC Lavalin (2017). 1:20,000 scale Terrain Stability Mapping;
- Klohn Crippen (1994). Surficial Deposits and Terrain Features;
- Terrain data collected by SNC Lavalin;
- Terrain data collected by EcoLogic; and
- Terrain data collected by Onsite Engineering Ltd (Onsite).

The 1:5,000 scale PFSA terrain mapping generally covered the north and east side of Bitter Creek where all project infrastructure is to be located. For the purposes of presentation and discussion in this report, the area mapped was clipped to the PFSA boundary. The mapping was completed by Polly Uunila, P.Geo., on Year 2013 digital air photos and Year 2013 high-resolution hillshade derived from bare earth LiDAR using 3D mapping software called ESRI PurVIEW. The 1994 scanned black-and-white air photos were used for areas not covered by the 2013 air photos. Terrain, terrain stability, and soil erosion potential mapping followed the current Provincial guidelines and standards outlined in Section 3.4.2.

5.2.1 Terrain and Bioterrain Mapping

Terrain mapping (surficial geology mapping) is a method of dividing the landscape into polygons based on surficial material type, surficial material depth, and landforms. Specialized forms of terrain mapping including bioterrain, terrain stability, and soil erosion potential mapping, were completed for this project. Terrain mapping is used to support other mapping products including TEM. Additional criteria used for polygon delineation to create bioterrain, terrain stability and soil erosion potential mapping include:

- soil drainage;
- surficial material texture;
- slope steepness;
- slope breaks;
- slope position;
- aspect: cool (from 285° to 135°) and warm (from 135 to 285°);
- geomorphological processes (i.e., natural hazards);
- surface expression and slope morphology (e.g., concave or convex and slope length);
- vegetation types;

- riparian zones and corridors; and
- any other ecologically significant areas such as cliffs, talus slopes, and bodies of water (i.e., ponds).

Once the polygon boundaries were defined, the following information (i.e., terrain attributes) was identified for each polygon:

- surficial material (also known as, surficial geology, terrain type or landform);
- texture;
- geomorphological processes;
- soil drainage class;
- slope steepness range;
- terrain stability class; and
- soil erosion potential class.

An expanded terrain legend is presented in Appendix B. Appendix C provides definitions for surficial material types and Appendix D lists definitions for geomorphological processes mapped in this project.

5.2.2 Terrain Stability Classification

Terrain stability relates to the likelihood of discrete areas to undergo mass movement such as landslides, including slumps, slides, debris flows, and earthflows. The method for assigning terrain stability classes (TS classes) followed the provincial standard used in the BC forest industry (B.C. Ministry of Forests, 1999) for detailed terrain stability mapping. Each polygon was assigned one of five classes with TS class I to TS class III considered stable, TS class IV being potentially unstable, and TS class V being unstable (where failures in terrain are currently visible). The classes indicate the likelihood of instability resulting from resource development activities that occur in the upper few metres of the land surface within in-situ surficial materials and bedrock. Class IV polygons are expected to contain areas with a moderate likelihood of landslide initiation following development activity, such as road development. Class V polygons are expected to contain areas with a high likelihood of landslide initiation following development activities, or already have evidence of past mass movements.

The general guidelines used to determine terrain stability classes ratings are shown in Table 5.2.1. These guidelines are based primarily on slope gradient, surficial material type and texture, and the presence of geomorphological processes related to terrain instability. In addition, professional judgment was used in applying the criteria on a polygon by polygon basis. For example, the ratings may be adjusted according to site-specific factors such as slope morphology and soil drainage. A slope morphology that includes irregular, near-surface bedrock would generally be rated as more stable than a similar slope with a smooth profile, because bedrock irregularities are more likely to hold surficial materials in place. Relatively poorly drained, wet slopes may be prone to slope failures through a reduction in normal stress due to high pore water pressure in the soil. Where wetter areas are mapped on slopes with gradients that occur within the upper end of a slope steepness class range, the polygon may be rated one terrain stability class higher.

Table 5.2.1. Guidelines for the Assessment of Detailed Terrain Stability Classes

Dominant texture	Typical surficial material	Terrain Stability Class					
		I	II	III	IV		V
					Dissected slopes (-V)	Uniform slopes	
fine s, z, c, m	LG, E	< 10%	10 – 25%	25 – 40%	> 35%	> 40%	all materials and landforms that are unstable
s, sdm, sdz	LG, M	< 15%	15 – 30%	30 – 55%	> 45%	> 55%	
dzs, zds, g, sd, sr, sx	M, F, FG, C, M1, CG	< 20%	20 – 40%	40 – 60%	> 50%	> 60%	
a, b, resistant bedrock	C, R	< 25%	25 – 50%	50 – 70%	-	> 70%	

Numerical ranges in the table refer to the dominant range of hillslope gradients. See Appendix B for definitions of texture and surficial material type. The classes indicate the likelihood of instability resulting from development activities occurring in the upper few metres of in situ surficial materials and bedrock.

5.2.3 Soil Erosion Potential Classification

Soil erosion potential (SEP) refers to the potential for the initiation, transportation and deposition of mineral soil material to occur. Criteria to assess SEPS include slope steepness, slope morphology, material type and texture. The method for assigning surface erosion potential followed the provincial standard used in the forest industry (B.C. Ministry of Forests, 1999). SEP classed range from SEP class VL (very low) to SEP class VH (very high), and refer to in situ, un-vegetated surficial materials that are exposed as a result of development activities. The ratings do not apply to undisturbed vegetated terrain.

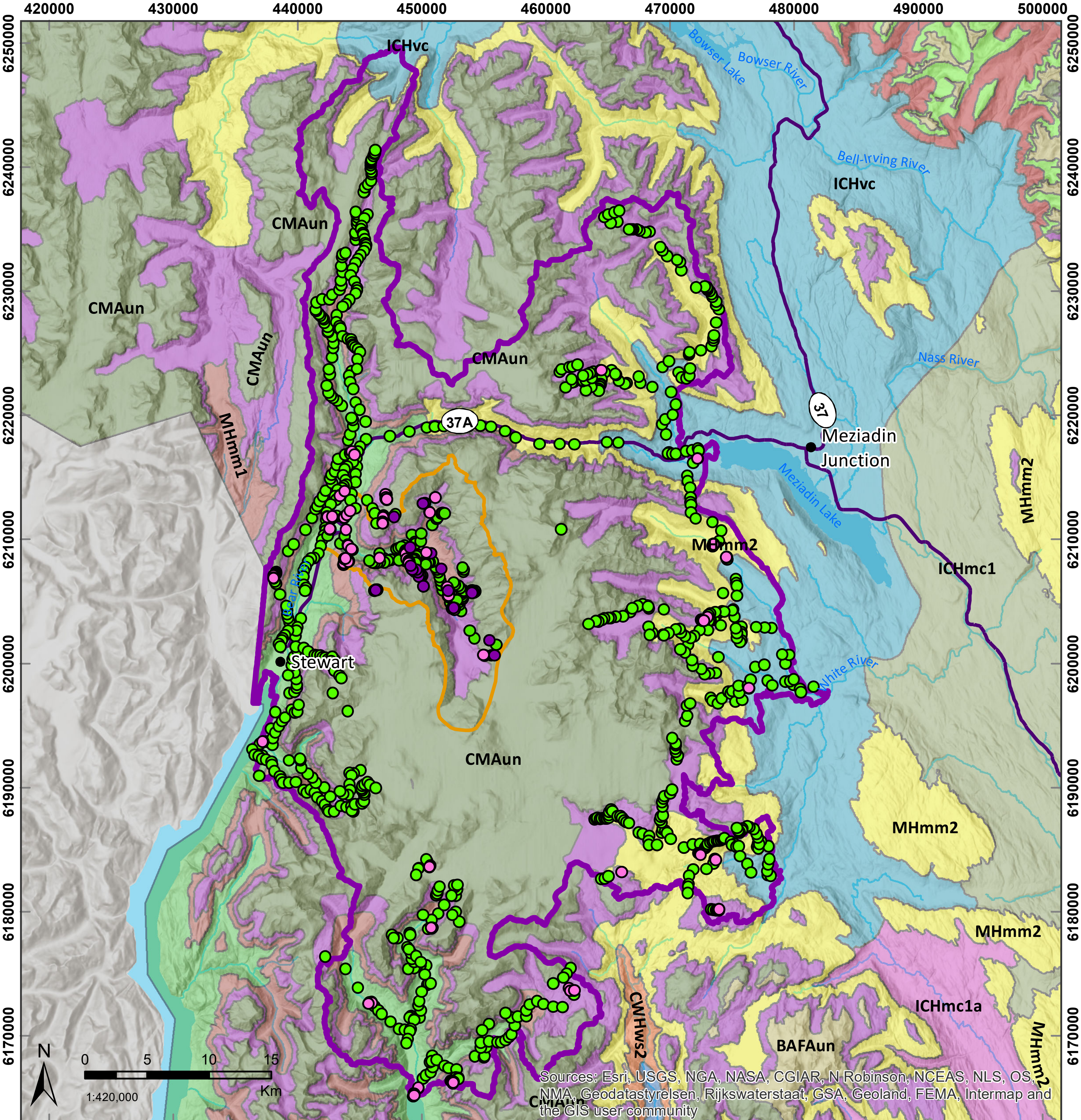
Sediments that are most susceptible to erosion include silt and fine sand with few or no clasts. Surficial materials with these properties may include glaciolacustrine, glaciofluvial and fluvial deposits, till, eolian sediments, as well as special situations such as colluvial deposits influenced by solifluction. Materials that are least susceptible to soil erosion consist of mainly coarse fragments (larger than 2 mm) with little or no matrix, peat, or bedrock. Coarse-grained materials that often contain little or no matrix include some types of colluvium, glaciofluvial and fluvial sediments, and washed ablation till.

The criteria used for rating SEP are shown in Table 5.2.2. These criteria serve as a guideline only and may be modified by the mapper due to other slope characteristics. For example, concave-shaped slopes (either across or down slope) tend to concentrate moisture and will generally have higher soil erosion potential ratings than straight or convex slopes. Similarly, slopes with abundant seepage will be given higher soil erosion potential ratings.

Table 5.2.2. Guidelines for the Assessment of Soil Erosion Potential Classes

Surficial Material Characteristics		Dominant Gradient Range (%)		
		0 – 40%	> 40%	> 30 - 40%
Dominant texture (In approximate order of decreasing erodibility)	Typical surficial material	Gentle to moderate gradient slopes; irregular, benched, terraced	Moderately steep and steep slopes	Dissected slopes
matrix supported: fine s, z, m	LG, M, E, F, FG	H	VH	VH
matrix supported: coarse s, ds, gs, sdm, sdz, c (cohesive)	FG, C, M, F, LG, M1	M	H, VH	VH
consolidated till	M	L	M	VH
clast supported: g, sd, sr, sx	F, FG, C, M, M1	L	M	H
resistant bedrock, talus slopes	R, C	VL	VL	VL
organics (peat bogs)	O	VL	-	-

Note: See Appendix B for definitions of texture and surficial material type. The classes indicate the likelihood of soil erosion resulting from mine development activities that expose in situ surficial materials.



Red Mountain Underground Gold Project

Sample Plot Locations in the Local and Regional Study Areas

Figure 5.1-1

ECOLOGIC environmental consulting

IDM MINING

Date: 6/13/2017

Map Number: RM-048

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

Legend

- Community
- Highway

Plot Type

- SIVI
- FS882
- Visual Plots
- Local Study Area
- Regional Study Area

BEC Zone

- CMAun
- CWHwm
- MHmm1
- MHmm2
- MHmmp
- ICHvc
- BAFAun
- CWHws1
- CWHws2
- ESSFun
- ESSFunp
- ICHmc1
- ICHmc1a

Red Mountain

5.3 Ecosystem Mapping

Three levels of ecosystem mapping were completed for the Project: Regional (the RSA), Local (the LSA) and Footprint (the PFSA). The RSA was mapped using Predictive Ecosystem Mapping (PEM) to model the general extent of ecosystem units in the regional landscape, while the LSA and PFSA were mapped using TEM.

5.3.1 Predictive Ecosystem Mapping

PEM was created using the most recent version of the LandMapR methodology originally created by Bob McMillan (LandMapper Environmental Solutions Inc. 2003) with revisions by John Simms (independent consultant). The LandMapR processing includes multiple stages, starting with modelling of soil moisture and nutrients, land cover classification, and final PEM assembly. PEM was completed for the 211,570-hectare RSA.

5.3.1.1 *Soil Nutrient and Moisture Modelling*

Soil Moisture Regime (SMR) and Soil Nutrient Regime (SNR) modelling was completed by John Sims and Ryan Gill (Cooper, Beauchesne and Associates Ltd.) using a combination of 'R' and Python scripts. The modelling was completed using 30-m-resolution federal Digital Elevation Models (DEM) processed using LandMapR scripts using standard variables and a 10-m cell size. Both models used a Random Forest model. Random Forests have been shown to be fairly robust in other PEM and soil moisture/nutrient projects. System for Automated GeoScientific Analyses (SAGA) layers were used preferentially over the LandMapR layers (for example, 'slope'). This preference for SAGA layers stems from the ease with which layers can be recreated in SAGA vs LandMapR. Field (FS882, SIVI and visual) and digital (manually digitized areas of known homogenous ecosystem type or site conditions) plots were pooled for use as training data; these plots were denoted as 'ground' or 'digital' to allow subsampling of each type during training. Both the nutrient and moisture models used several SAGA and LandMapR layers; the soil moisture regime model also included the fuzzy classification layers generated by LandMapR. The output of the modelling is comprised of two raster images (tif) that contain 10-m cells with SNR or SMR grid values (Table 5.3-1).

Table 5.3-1. Modelled SMR and SNR Grid (Raster) Values and the SMR and SNR Classes

SNR Grid Value	SNR
0	Very Poor
1	Poor
2	Medium
3	Rich
4	Very Rich

SMR Grid Value	SMR
0	Very Xeric
1	Xeric
2	Subxeric
3	Submesic
4	Mesic
5	Subhygric
6	Hygric
7	Subhydric
8	Hydric

5.3.1.2 *Image Classification*

Image classification was completed by Ryan Gill using Landsat 8 satellite imagery. The imagery has a spatial resolution of 30 m x 30 m and an acquisition date of August 12, 2013. The version of imagery was selected after assessing the available tiles for cloud cover and dates that were as close to the field sample plot data as possible.

Classification of 15 land cover classes (Table 5.3-2) in RSA was accomplished using the statistical program R[2]. Inputs to the classification process consisted of multi-spectral imagery (bands 1 to 7) provided by IDM in raster format and training areas of known land cover classes. Prior to the classification, all raster files were projected and sampled to ensure identical extents and resolution.

Training areas were provided as polygons with varying areas. To simplify the training process, randomly distributed points were generated for each training polygon, and assigned the land cover classes for that polygon. Approximately five training points per hectare were assigned to each polygon. The training dataset was then assigned covariates from each of the seven input bands, in addition to the value of the known land cover classes at that point.

Using the R libraries, 'spatial', 'raster', 'rgdal' and 'caret', these training data were processed and then analyzed with a machine learning algorithm. Using the 'caret' package in R, a Random Forest classifier was used to choose the optimal model across all parameters, and estimate the model performance from the training set (K-fold cross validation). The final model was then used to predict the land cover classes across the RSA covered by bands 1 to 7.

[2] R Core Team. 2014. R: a language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria. Retrieved from http://www.R-project.org.

Table 5.3-2. Land Cover Derived from the Image Classification Process

Classification	LandCov
Broadleaf Forest	1
Broadleaf Shrub	2
Conifer Forest	3
Conifer Shrub	4
Dwarf Shrub - Heath	5
Herb Wetland	6
Exposed Soil	7
Glacier	8
River and Gravel Bar	9
Herb Meadow	10
Mixed Forest	11
Mixed Shrub	12
Water	13
Rock	14
Tundra	15

5.3.1.3 *PEM Assembly*

EcoLogic assembled the final PEM with review and input from Adrian de Groot (Drosera Ecological Consulting). All modelling data were converted to polygons using the raster to shapefile tool in ArcGIS 10.3.1. The Analysis toolbox was then used to run an *Identify* process to combine the SMR, SNR, and image classification attributes into a single polygon layer while maintaining all attributes and polygon shapes. The resultant polygon layer was then clipped to the most recent provincial Biogeoclimatic Ecosystem Classification (BEC) mapping layer to separate the data into discrete files for each BEC subzone/variant/phase. The separation was done to facilitate the final modelling and reduce the total area and number of polygons we were working with. The small amount of BAFAun in the study area was merged with the CMAun as it was limited to a small area of pure glacier.

The raw data was then used to predict ecosystem types for each polygon. Ecosystem predictions were then made for each polygon using a legend derived from:

- A Field Guide to Site Identification for the Prince Rupert Forest Region (Banner et al., 1993);
- BGC Codes and Names database, Version 8, Feb 2012 (BC Ministry of Forests and Range, 2016);
- Wetlands of British Columbia (MacKenzie and Moran, 2004); and
- Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia (MacKenzie, 2012).

One or more map codes were entered for each polygon after all the expected ecosystem types were modelled using the expected SMR and SNR range from the guide books, along with professional opinion and field data regarding how the image classification related to ecosystem types. For the majority of the polygons a single code was entered, indicating that the polygon contained a pure ecosystem type. For a small number of ecosystems, a pure type could not be determined (e.g., two floodplain ecosystems that occur in similar locations and have overlapping SMR/SNR values), or two ecosystems that had similar attributes could not be spatially separated using the available data (e.g., shrub avalanche and edaphic shrub-dominated thickets). These complex units were mapped with both ecosystem codes and a separator (e.g., Vs | Sc) to indicate that one or both ecosystem types occurred, with dominance not assigned. For some non-forested ecosystems, the image classification was given preference over the modelled SMR/SNR, and all polygons with that land cover classification were assigned to a single ecosystem type (such as glacier and water) as the image classification was found to be accurate.

For each BEC unit, a number of polygons remained after the SMR/SNR combinations expected for each ecosystem types were assigned. These polygons, typically accounting for 1 to 2% of the total polygons, were given ecosystem codes using a trial and error and best-fit method, typically using the closest match of SMR/SNR from the Site Identification guidebook.

Several manual manipulations and exclusions were done to further refine the mapping:

- Elevation (TRIM contours lines) was used in the Bear River and Bitter Creek valleys to better determine where floodplain ecosystem ended;
- Exclusion areas were created to pull out the developed areas around Stewart;
- TRIM roads were edited as needed (to reflect current road systems) and given a 10-m buffer from the road centerline. The roads were then cut from the PEM to indicate disturbed road areas; and
- The GeoBC (Gov. of BC 2016) river polygon was also used to cut the PEM data as it was found to be more accurate than the modelled land cover data.

The final map was then assigned assumed structural stage attributes to facilitate the end use wildlife habitat suitability mapping. Structural stages were assigned based on the descriptions provided in the Field Manual for Describing Terrestrial Ecosystems; 2nd Edition (BC MOF, 2010), and range from a single structural stage to an expected range of structural stages.

5.3.1.4 *Quality Assurance and Quality Control*

Adrian de Groot reviewed the modelling results and provided extensive feedback that was incorporated into the final product. Spatial and attribute QA/QC were completed by an EcoLogic geomatics specialist.

5.3.2 Terrestrial Ecosystem Mapping

TEM provides a uniform approach to ecological landscape classification and mapping, which can then facilitate the integration and exchange of ecosystem knowledge across multiple areas of study. TEM is necessary to provide information regarding ecological values and functions to resource managers and practitioners. TEM is required for project planning and infrastructure layout (to minimize or mitigate project impacts); identification of rare or sensitive wildlife habitat; identification of rare, sensitive or traditional use plants and associated habitat; and the mapping of special landscape features, such as wetlands and floodplains. For development projects such as mines and pipelines, TEM provides a foundation to facilitate discussions of project interactions with geomorphology, soils, permafrost, ecosystems, rare plants, country foods, traditional use plants, special landscape features, and wildlife habitat.

TEM uses the established BEC system to define the regional zone and provide descriptions of ecosystem types that are expected to occur. The BEC system groups ecosystems at three levels (regional, local, and chronological) based on vegetation, soils, topography, and climate. At the regional 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. At the local level, sites are classified based on vegetation characteristics, soils, and topography, with site series assigned to specific local ecosystem units. Vegetation is the most important factor for ecosystem classification; however, it is based on climax and zonal theories, where the vegetation observed in a young or disturbed site may not necessarily reflect the species composition of a mature or old site (BC Ministry of Forests and Range, 2016; RIC, 1998).

Bioterrain mapping is the first part of the process, where mapped terrain polygons are used to map areas of like soils and topology. Ecosystem mapping uses the bioterrain polygons (and dividing them into smaller polygons as needed) to map and classify ecosystem types, along with additional descriptors that provide information on the current state and condition of each ecosystem.

The TEM was conducted using digital 2013 colour air photos that were custom flown for the Project and black and white 1994 air photos that were scanned from hard copy imagery. The 2013 imagery covers the proposed infrastructure areas and a sizeable adjacent area. The 1994 imagery covers the majority of the LSA; however, there are three portions of the LSA that fall outside of the imagery coverage and as a result were not mapped. Mapping was completed in stereo using various versions of ArcMap 10 and PurVIEW. Vertical control for PurVIEW included the use of provincial TRIM 20-metre contour elevation data. Mapping products completed for the Project include the following:

- 1:20 000 terrain mapping completed in 2016 by SNC Lavalin;
- 1:5 000 bioterrain mapping completed in 2016 by Polar Geoscience;
- 1:5 000 soil mapping in 2017 by Dave Yole;
- preliminary 1:20 000 TEM completed in 2016 by Triton Environmental Consultants;
- revised 1:20 000 TEM completed in 2017 by EcoLogic; and

- 1:5 000 TEM completed in 2017 by EcoLogic.

Mapping was completed in accordance with the following provincial guidelines:

- Standard for Terrestrial Ecosystem Mapping in BC (1998); and
- Standard for TEM Digital Data Capture in BC, Version 3.0 (2000).

Ecosystem classification was completed using the following field guides and resources:

- Biogeoclimatic Ecosystem Classification codes and names (BECdb version 8, Feb 2012);
- Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia (MacKenzie 2012);
- Wetlands of British Columbia: a guide to identification (MacKenzie and Moran 2004);
- Field Manual for Describing Terrestrial Ecosystems; 2nd Edition (BC Ministry of Forests and Range and BC Ministry of Environment 2010); and
- A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region (Banner et al. 1993).

Each terrain/bioterrain polygon is attributed with ecosystem descriptions or, if it contains multiple ecosystem types, split into smaller ecosystem polygons which are attributed uniquely. Ecosystem polygons may be pure units (map and describe a single ecosystem type) or contain a complex unit that describes up to three ecosystem types (Figure 5.3-1). An expanded TEM legend is located in Appendix E.

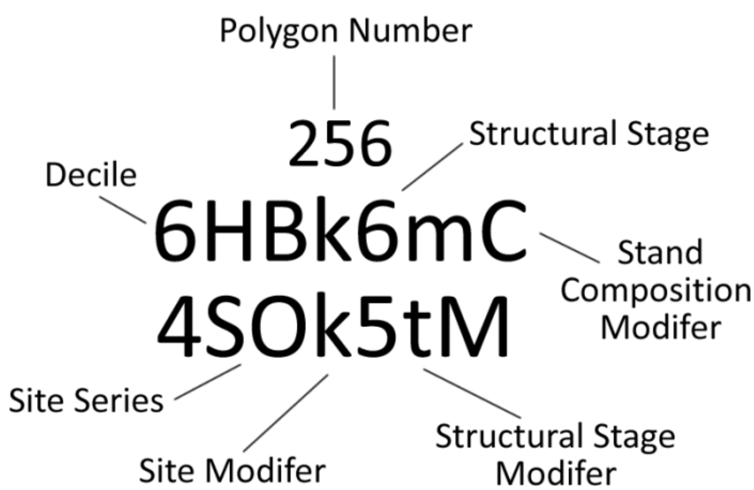


Figure 5.3-1. Compound Ecosystem Unit

Quality assurance and quality control (QA/QC) was carried out throughout each phase of the TEM process. Initial polygon delineation for TEM mapping was checked for slivers and other errors by senior GIS staff. Once polygons were attributed, image interpretation and data entry were assessed by a senior ecologist. Field data cards were assessed for entry and interpretive errors.

The preliminary 1:20 000 mapping was reviewed by senior ecologists for both ecosystem classification and for completeness of mapped attributes. The revised 1:20 000 TEM was reviewed primarily for mapped attributes. The 1:5000 TEM was reviewed using a random polygon selection process and revised as necessary. TEM reviewers included:

- Adrian de Groot, R.P.Bio.;
- David Yole, P.Ag.;
- Ryan Durand, R.P.Bio.;
- Daniel McAllister, P.Ag.; and
- Jackie Churchhill, R.P.Bio.

5.4 Sensitive Ecosystems

Sensitive ecosystems represent ecosystems that share many characteristics, particularly ecological sensitivities, ecological processes, rarity, and wildlife habitat values (Iverson and Cadrin 2003). Ecosystems are typically considered to be sensitive if they have one or more of the following attributes:

- sensitive to disturbance and human impacts.;
- rare or of restricted distribution (based on BC CDC ranks);
- high biodiversity; and
- high values as habitat, especially for known or potentially occurring species at risk.

For this Project, sensitive ecosystems were determined to be those within the following categories:

- wetlands and floodplains;
- mature and old forests;
- alpine and parkland forests; and
- ecosystems-at-risk (i.e., listed by BC Conservation Data Centre).

Sensitive ecosystems were identified using the LSA and PFSA ecosystem mapping.

5.4.1 Wetlands

A wetland is defined as land that is 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). Key to this is that soils are saturated by water for enough time that the excess water and resulting low oxygen levels influence the vegetation and soil. The water influence can be either seasonal or year-round and occurs either at or above the soil surface or within the root zone of plants. Wetlands can be found in depressions and areas of flat or undulating terrain.

The development of wetlands is a dynamic function of climate, hydrology, chemistry, geomorphology, and biology (National Wetlands Working Group, 1997). Wetlands are not generally stable ecosystems over the long term; rather they are constantly evolving over time (hundreds or thousands of years); this occurs as soils develop and water regimes change, resulting in communities that often contain aspects of different wetland types, as well as transitional areas where they are indeterminate between one class or association and another. Therefore, multiple characteristics of wetlands, due to the interaction of various environmental factors, are required to place them in specific classes and associations. Wetlands in Canada are classified by morphology by Canadian System of Wetland Classification using five classes: bog, fen, marsh, swamp, and shallow open water (National Wetlands Working Group, 1997), and further refined by dominant vegetation associations based on the system presented in Wetlands of British Columbia (MacKenzie and Moran, 2004).

5.4.2 Floodplains

Floodplains are dynamic ecosystems that are classified by their connection (landscape position) to a river or creek. Provincial guidebooks group these ecosystems into low, medium and high-bench floodplain ecosystems (MacKenzie and Moran, 2004). Low-bench floodplains occur in the active floodplain where significant flooding occurs on an annual (or more frequently on small systems with less ability to retain water from large precipitation events) basis. The flooding typically is persistent are results in either souring or deposition of bed substrate, which largely precludes the establishment of forested ecosystems. They are typically characterized by a sparse to thick cover of shrubs (such as willow, alder or cottonwood), little to no soil development, and lack of herb or moss cover. Mid-bench floodplains occur at a higher elevation from the river or creek. They experience annual flooding or vertical changes in groundwater levels, and are subject to powerful flooding during high water years. Mid-bench floodplains are relatively stable ecosystems that are typically dominated by deciduous trees such as cottonwood and have few to no conifer tree species. High-bench floodplains are on largely inactive fluvial plains where regular flooding does not occur and flooding of any kind is rare. They remain connected to the riverine system through seasonal fluctuations in groundwater and typically support conifer and deciduous forests (MacKenzie and Moran, 2004).

Floodplain ecosystems are connected to, and highly dependent on, hydrological connections to creeks and rivers. Creeks and rivers provide regular flooding and groundwater, nutrients, and the exchange of biotic material (Ickes et al., 2005). The connection to the river system is considered to be essential for ecological health and viability of floodplain ecosystems, and contributed to floodplains being one of the most productive and biodiverse ecosystem types in a given landscape (Ickes et al., 2005; Junk et al., 1989). Physical alterations such as dykes, roads and dams disconnect floodplain ecosystems from rivers and creeks, resulting in ecological degradation and a reduction in a variety of ecological services (Ickes et al., 2005).

5.4.3 Mature and Old Forest

Mature forests are defined as stands that have a mature canopy, typically with a distinct second cycle of shade-tolerant trees in the lower canopy. Mature stands typically have a complex vertical structure with distinct layers of tree canopies, normally reflecting tree species. Time since disturbance is typically 80 to 140 years (up to 240 years in cold subzones). Shrub and herb understories are well developed in open patches due to access to light. In higher elevation and cold areas (such as the MHmmp) the canopy may be limited to a single layer (or be open-spaced or irregular in structure) and contain stand characters that are more similar to younger forests (BC Ministry of Forests and Range & BC Ministry of Environment, 2010).

Old forests are defined by stands that have complex structures (including the presence of old trees and snags). Lower canopies and regeneration are using the same shade-tolerant species as found in the main canopy. Shrub and herb cover is patchy, ranging from thick cover in openings as old trees fall out, to sparse or absent cover under dense, continuous canopy cover. Large woody debris on the forest floor is always present and occurs in a variety of decomposition stages (including nurse logs). Old forests are considered to occur 140 to 250 years from stand-replacing disturbance, with very old standing occurring at over 400 years from disturbance. Old stands occurring at higher elevation and in cold environments often lack many of the typical old growth characteristics (BC Ministry of Forests and Range & BC Ministry of Environment, 2010).

The ecological value of mature and old forests is well known, ranging from old-growth dependent species, carbon sequestration, biodiversity, and genetic diversity (Mosseler, Thompson, & Pendrel, 2003); (Fredeen, Bois, Janzen, & Sanborn, 2005). Mature to old forests typically have a greater diversity of flora and fauna, including arboreal and underground (soil) species, relative to young stands (Lesica, McCune, Cooper, & Hong, 1991; Qian, Klinka, & Sivak, 1997). Studies have indicated that both the time since disturbance and the structural diversity with old-growth results in a more diverse assemblage of species, often including listed species that require highly specialized habitats (Lesica et al., 1991; McCune, Rosentreter, Ponzetti, & Shaw, 2000).

5.4.4 Alpine and Parkland

Alpine ecosystems are characterized by an absence of trees due to climatic and edaphic conditions associated with higher elevations. Common ecosystems include heath, tundra, herb meadows and krummholz. Non-vegetated areas, such as permanent snow, ice fields, rock outcrops, and barren soil, are also common. Parkland ecosystems represent the transitional zone in between forested subzones at lower elevations and the true alpine at higher elevations parkland is often characterized by groupings of trees distributed within krummholz, grasslands, heath, and herb meadows.

Alpine ecosystems are considered sensitive because disturbed alpine vegetation is fundamentally altered from its original ecological trajectory, even in the long-term (Forbes, Ebersole, & Strandberg, 2001; Frank & del Moral, 1986; Mingyu, Hens, Xiaokun, & Wulf, 2009). This situation is particularly true of dwarf shrubs and krummholz. Studies have also indicated that disturbed alpine ecosystems may recover to a stable-state community with different species assemblages than were present pre-disturbance (Forbes, 1996; Becker and Pollard, 2016).

Alpine ecosystems are important seasonal habitat, providing forage, breeding areas, and escape terrain from predators and insects. For example, alpine ecosystems provide habitat for blue-listed mountain goat (*Oreamnos americans*); the blue-listed wolverine (*Gulo gulo*), which is also a species of Special Concern federally under the *Species at Risk Act* (McNay et al., 2009); grizzly bear (*Ursus arctos*); and hoary marmots (*Marmota caligata*). Grizzly bear forage extensively in alpine and meadow areas in the summer and fall. Hoary marmots dig burrows in rocky talus slopes and alpine tundra ecosystems. Protecting alpine ecosystems is also a goal of the Cassiar-Iskut Stikine Land and Resource Management Plan (BC ILMB, 2000).

5.4.5 BC CDC Listed Ecosystems

In British Columbia, at-risk ecosystems and plants are ranked according to factors such as rarity, intrinsic vulnerability, environmental specificity, threats, and long- and short-term trends in population size by the British Columbia Conservation Data Centre (BC CDC). The BC CDC defines an at-risk ecosystem as “an extirpated, endangered or threatened ecosystem or an ecosystem of special concern” and categorizes at-risk ecosystems and plants as either Red-listed or Blue-listed depending on their rank status, location, and level of protection (Table 5.4-1; MOE 2016). Plants that are common and secure within the province are categorized as Yellow-listed.

Table 5.4-1. BC Conservation Data Centre Status Ranks and Definitions

Rank Status	Definition
Red-listed	Plants that have, or are candidates for, Extirpated, Endangered or Threatened status in BC. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered, or Threatened under the *Wildlife Act* (1996).
Blue-listed	Plants of “special concern” (formerly vulnerable) status in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events.
Yellow-listed	Plants that are common and demonstrably secure.

In addition to the BC CDC Conservation Rank Status, ecosystems and plant species are assigned a conservation rank by NatureServe. Conservation status assessments are completed to produce conservation status ranks that measure extinction or extirpation risk at three geographic scales: Global (G-Ranks), National (N-Ranks) and Subnational (S-Ranks; Table 5.4-2).

Ecosystems at risk were identified based on queries of the BC CDC for the BEC units located within the RSA (Appendix F). From the regional list of potential ecosystems-at-risk, the units that may occur within the LSA and PFSA were identified (Table 5.4-3). The results of the TEM mapping and field sampling were then cross-referenced with the CDC list to identify listed ecosystems.

Table 5.4-2. NatureServe Subnational Conservation Status Ranks and Definitions

NatureServe Subnational Rank[1]	Definition	BC CDC Rank Equivalent
S1	Extremely rare at the provincial level; five or fewer occurrences, or very few remaining individuals; critically imperiled and susceptible to extirpation due to a factor of its biology	Red-listed
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[2]	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	Blue-listed
S2S3	Rare to vulnerable at the provincial level	
S3S4	Vulnerable to common 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	Yellow-listed
S5	Very common and demonstrably secure at the provincial level; more than 100 occurrences	

[1]The NatureServe ranks and definitions at the national (N ranks) and global level (G ranks) are available on their website (NatureServe 2015).
[2] A Range Rank (i.e., S2S3) is used when existing information on an element straddles the criteria defining two separate ranks.

Table 5.4-3. Potential CDC Listed Ecosystems in the LSA and PFSA

Ecosystem Group	Scientific Name	English Name	Prov Status	BC List	BEC Unit
Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Mixed - moist/wet	Picea sitchensis / Rubus spectabilis Wet Maritime	Sitka spruce / salmonberry Wet Maritime	S3	Blue	CWHwm/05
Terrestrial - Flood: Flood Lowbench (Fl)	Alnus incana / Equisetum arvense	mountain alder / common horsetail	S3	Blue	CWHwm/Fl01
Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet	Populus trichocarpa - Alnus rubra / Rubus spectabilis	black cottonwood - red alder / salmonberry	S3	Blue	CWHwm/06
Terrestrial - Forest: Coniferous - dry	Tsuga heterophylla - Picea sitchensis / Hylocomium splendens	western hemlock - Sitka spruce / step moss	S3	Blue	CWHwm/02

Ecosystem Group	Scientific Name	English Name	Prov Status	BC List	BEC Unit
Terrestrial - Forest: Coniferous - moist/wet	Tsuga heterophylla / Sphagnum girgensohnii	western hemlock / common green peat-moss	S3	Blue	CWHwm/08
Terrestrial - Forest: Coniferous - moist/wet;Wetland - Mineral: Wetland Swamp (Ws)	Picea sitchensis / Lysichiton americanus	Sitka spruce / skunk cabbage	S3	Blue	CWHwm/09
Wetland - Mineral: Wetland Swamp (Ws)	Salix sitchensis - Salix lasiandra var. lasiandra / Lysichiton americanus	Sitka willow - Pacific willow / skunk cabbage	S2	Red	CWH/Ws51
Wetland - Peatland: Wetland Fen (Wf)	Carex sitchensis / Sphagnum spp.	Sitka sedge / peat-mosses	S2	Red	CWHwm/Wf 51

5.5 Soils Mapping and Classification

5.5.1 Soil Inspections

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

5.5.2 Soils Map Units

The Soil Map Unit (SMU) is the basic map unit used to describe the soil types within a mapped polygon. SMUs aggregate the soil development and surficial material types into groups that can be interpreted for various uses and 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 suitability for 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.

The identification and description of SMU types includes a description of general characteristics and soil conditions for each general soil type and are seen as the average or most common characteristics such as soil texture, parent material, drainage, general soil nutrient and moisture regime, depth to water table or seepage, soil colour, percent coarse fragment volume (%) and other soil and terrain mapping attributes.

Soil classification abbreviations common to each SMU are described in the Canadian System of Soil Classification (CSSC, 1998).

There is considerable overlap with terrain mapping and SMU designation, especially with regards to slope stability, identification of gravel sources, surface soil erosion, and salvage potential, although the soils map provides more precise soils information as a soil planning tool at the disposal of the land manager for reclamation activities.

A SMU legend is applied to SMU maps and describes the general attributes of the SMUs as assessed for each polygon shown on the soil map. The GIS database includes a polygon number, the surficial material type, soil drainage (as interpreted by SMR), Soil Salvage Potential (SSP), Surface Erosion Potential (SEP), as well as subgroup information where considered relevant to further interpretation. Soil phase information (e.g., shallow soils to rock) is accounted for by a unique unit. For example, *SMU 6d* describes shallow colluvial deposits within active avalanche tracks, often with seepage and gullying geomorphic processes occurring.

SMUs are sorted into Soil Groups reflecting their general soil management issues such as reclamation potential, salvage depth, and suitability. Common landscape characteristics such as slope gradient and soil moisture can impact soil handling operations, and are included in the following discussion.

Depth to bedrock is assumed to be within 1 m 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 LSA and PFSA, these commonly include:

- (A) snow avalanches — common to polygons with colluvial (C) and morainal (M) surficial materials;
- (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 fan-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.

5.5.3 Soil Salvage Potential in the PFSA

Each bio-terrain polygon during the attributing phase of the data compilation/analyses was assessed for SSP. Multiple information sources including plot data, slope position, and ecosystem productivity were used to assist in estimating SSP (Table 5.5-1). Combination categories (e.g. P-M, N-VP) were employed in complex or variable SMU polygons.

Table 5.5-1. Soil Salvage Potential Category Ratings at the Red Mountain Project PFSA

Criteria	Good (G)	Moderate (M)	Poor (P)	Very Poor (VP) or Nil
Ah depth (cm)	3-10+	1-3cm	0	0
Mineral Texture	SiL, fine L, SL, fine S	LS, SiCL	S, C[1], SC, L, CL	HC, SiC
Root Zone depth	40-75+	25-40	<10-25	<10
Coarse Fragment Content (%)	<20	20-45	45-70	>70
Reaction (pH)	6.5-7.5	5.5-6.4	4.5-5.4	<4.5 >9
Calcareous Subsurface	Nil to minor fizz	Moderate fizz	Strong fizz; Visible salt crystals	Very strong fizz
Containment Structures	HC, C	SiCL, L	n/a	n/a

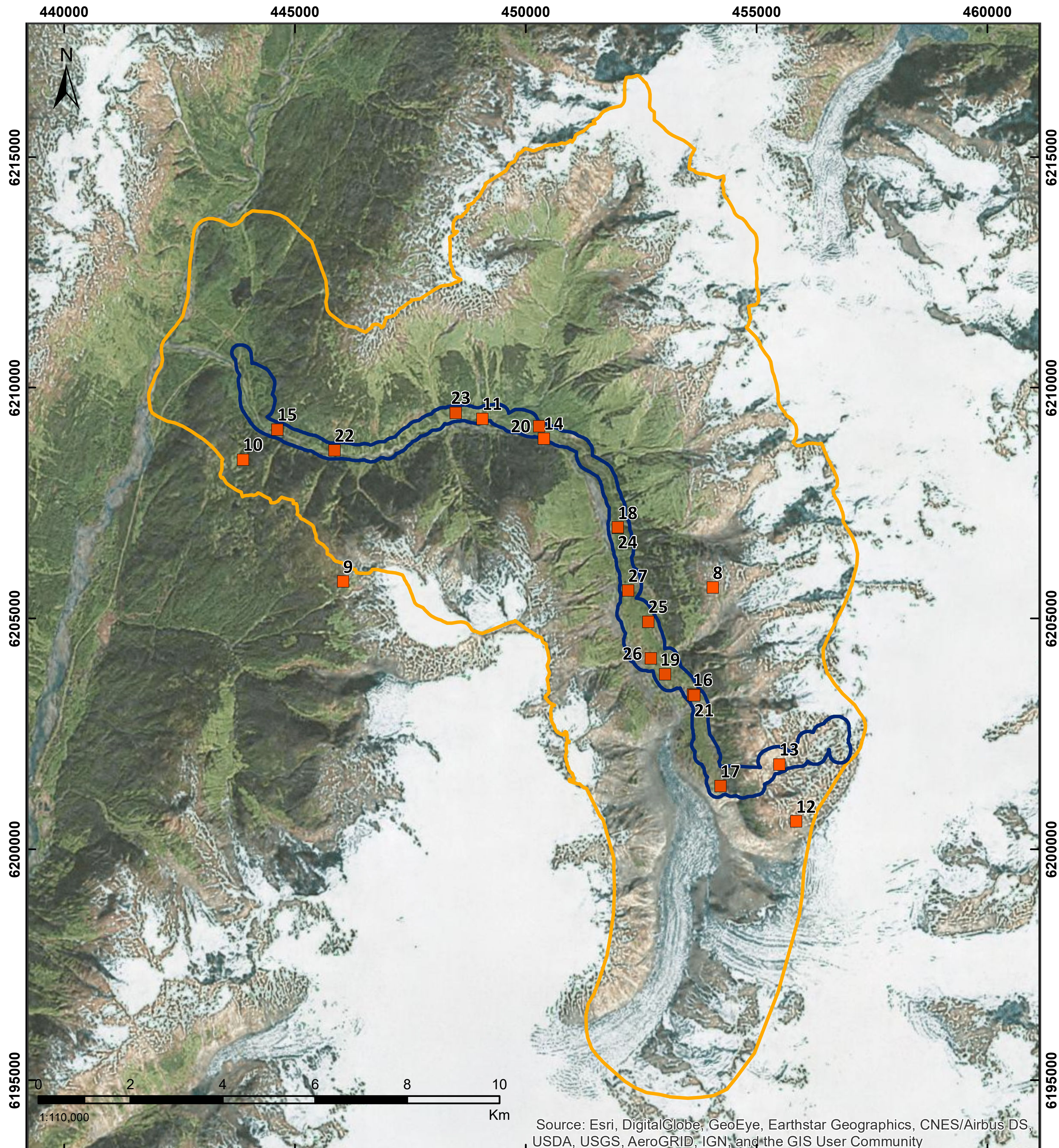
[1]*Clay (C) mineral texture can be useful in containment structures, otherwise can result in compaction.*

5.6 Laboratory Soil Analysis

As part of the baseline studies conducted in 2016, soil samples were collected to establish current metal concentrations. Samples were collected from 21 sites within the LSA, and locations are presented in Figure 5.6-1. Approximately one litre of soil was collected at each site. Samples were kept cool and sent to the Caro Labs as soon as practical for subsequent drying, sieving, and subsampling prior to lab work by standard BC methodology for soil analysis. Generally the 0 to 15 cm surface layer of mineral soil was sampled from each site for particle size, soil fertility, and metal determination.

The metals analyses determine current 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 changes in metal levels due to the Project. Results from the metals analysis may be used for human health assessments and/or future monitoring programs. All analyses were carried out by Caro Labs in Richmond, BC.

The interpretation of baseline data included comparing analytical results to the industrial guidelines provided for 19 metals, by the Canadian Council of Ministers of the Environment (CCME 2007; Table 5.6-1). Additional parameters, including 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 (Tables 5.6-2 to 5.6-4).



Red Mountain Underground Gold Project

Tissue and Soil Sample Locations for Metal Analysis

Figure 5.6-1

Date: 6/13/2017

Map Number: RM-047

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

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Legend

Local Study

Project Footprint Study Area

Sample Type

Soil Sample

Table 5.6-1. 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 5.6-2. Summary of the Analyses Completed

Parameter	Type of Analysis
Analysis of Contaminated Sites Regulation (CSR) Metals	Inductively Coupled Argon Spectrograph Analysis
Carbon	Total Carbon and Organic Carbon
Texture	Grain size analysis using three point texture
Cation Exchange Capacity	
$CaCO_3$ equivalence	

Table 5.6-3. Laboratory Parameters for Soil Analysis

Limitation / Property	Analysis	Method
Reaction (pH)	pH in soil, $CaCl_2$	APHA 4500-H +B
Reaction (pH)	pH in soil, saturated paste	APHA 4500-H +B
Salinity (EC; dS/m)	Salinity package	APHA 2510 B
Sodicity (SAR)	Included in salinity pkg.	Carter 15.4.4
Saturation %	Included in salinity pkg.	Carter 15.2.1

Limitation / Property	Analysis	Method
% coarse fragments	Particle Size dry sieve	In-house
Texture	Particle size, hydrometer	Carter 55.3
Consistence (moist)	Dry weight	ASTM D2974-87
% Organic carbon (topsoil	Carbon, Total organic in solids	Carter 21.2
$CaCO_3$ equivalent (%)	Calcium Carbonate Equivalents	SC SSHC 304.04

Table 5.6-4. Soil analysis, Red Mountain Project, 2017

General Method	Analyte	Units	MRL
Suitability Characteristics			
General Parameters	Calcium Carbonate Equivalence	% dry	0.1
General Parameters	Carbon, Total Organic	% dry	0.05
General Parameters	Moisture	% wet	0.1
Salinity Parameters (Sat. Paste Extract)	Sodium Adsorption Ratio	-	0.1
Salinity Parameters (Sat. Paste Extract)	Conductivity, Saturated Paste	ds/m	0.1
Salinity Parameters (Sat. Paste Extract)	Calcium, Saturated Paste	meq/L	0.2
Salinity Parameters (Sat. Paste Extract)	Magnesium, Saturated Paste	meq/L	0.02
Salinity Parameters (Sat. Paste Extract)	Potassium, Saturated Paste	meq/L	0.01
Salinity Parameters (Sat. Paste Extract)	Sodium, Saturated Paste	meq/L	0.02
Salinity Parameters (Sat. Paste Extract)	Calcium, Saturated Paste	mg/L	4
Salinity Parameters (Sat. Paste Extract)	Magnesium, Saturated Paste	mg/L	0.2
Salinity Parameters (Sat. Paste Extract)	Potassium, Saturated Paste	mg/L	0.4
Salinity Parameters (Sat. Paste Extract)	Sodium, Saturated Paste	mg/L	0.4
Salinity Parameters (Sat. Paste Extract)	pH, Saturated Paste	pH units	0.1
Particle Size Distribution	> 2.0 mm	%	0.1
Particle Size Distribution	Sand	% dry	2
Particle Size Distribution	Silt	% dry	2
Particle Size Distribution	Clay	% dry	2
Soil Metals			
Strong Acid Leachable Metals (SALM)	Antimony	mg/kg dry	0.1
Strong Acid Leachable Metals	Arsenic	mg/kg dry	0.4
Strong Acid Leachable Metals	Barium	mg/kg dry	1
Strong Acid Leachable Metals	Beryllium	mg/kg dry	0.1
Strong Acid Leachable Metals	Cadmium	mg/kg dry	0.04
Strong Acid Leachable Metals	Chromium	mg/kg dry	1
Strong Acid Leachable Metals	Cobalt	mg/kg dry	0.1
Strong Acid Leachable Metals	Copper	mg/kg dry	0.2
Strong Acid Leachable Metals	Lead	mg/kg dry	0.2
Strong Acid Leachable Metals	Mercury	mg/kg dry	0.04

General Method	Analyte	Units	MRL
Soil Metals (*cont'd*)			
Strong Acid Leachable Metals	Molybdenum	mg/kg dry	0.1
Strong Acid Leachable Metals	Nickel	mg/kg dry	0.4
Strong Acid Leachable Metals	Selenium	mg/kg dry	0.5
Strong Acid Leachable Metals	Silver	mg/kg dry	0.2
Strong Acid Leachable Metals	Thallium	mg/kg dry	0.1
Strong Acid Leachable Metals	Tin	mg/kg dry	0.2
Strong Acid Leachable Metals	Uranium	mg/kg dry	0.05
Strong Acid Leachable Metals	Vanadium	mg/kg dry	0.4
Strong Acid Leachable Metals	Zinc	mg/kg dry	2

The methods of analyses are described in the Caro Analytical Services Certificate of Analysis (Appendix H), and summarized as follows:

- Calcium Carbonate Equivalence in Soil;
- Carbon, Total Organic in Soil (Carter 21.2, Catalytic Combustion and Infrared Detection);
- Metals in Sat. Paste Extract by ICPMS in Soil EPA 6020A, Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS);
- Particle Size [Sand, Silt, Clay] in Soil (Carter 55.3, Hydrometer Method);
- Particle Size [>,< 2 mm] by Dry Sieve in Soil;
- SALM by ICPMS in Soil (BCMOE SALM V.2 / EPA 6020A, HNO_3+HCl Hot Block Digestion/ Inductively Coupled Plasma-Mass Spectroscopy [ICP-MS]);
- Saturated Paste Conductivity in Soil (APHA 2510 B Conductivity Meter);
- Saturated Paste pH in Soil (APHA 4500-H+ B Electrometry); and
- Sodium Adsorption Ratio (Calculation) in Soil (Carter 15.4.4, Calculation [based on the concentration of Na/Ca/Mg in Sat. Paste extract]).

For context, the results of the soil metals analyses were compared against soil concentration criteria developed for specific land uses. The most stringent criteria are developed for Agricultural Land Use (federal CCME and Province of BC CSR, Schedule 4). The most limiting concentration between the federal and provincial criteria was chosen, if more than one value was indicated. For further context, results comparisons were also made against the less stringent Industrial Land Use criteria to highlight the magnitude of the exceedance of criteria.

Method references included: (see Appendix H, Certificate of Analysis):

- APHA Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health;

- Association/American Water Works Association/Water Environment Federation;
- ASTM International Test Methods;
- Carter Soil Sampling and Methods of Analysis, 2nd Edition (2007), Carter/Gregorich; and
- EPA United States Environmental Protection Agency Test Methods.

5.7 Plants of Conservation Interest

5.7.1 Overview

Appendix I contains a BC CDC list of at-risk plants and lichens that are known to occur in the ecosections in which the Project is located.

5.7.2 Field Survey Design

Rare plant surveys were conducted to identify those species that are Red- or Blue-listed by the BC CDC, have a conservation-priority S-ranking, have protection under the SARA; or are 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, rock outcrops, alpine scree slopes, and wetlands) were selected for the rare plant surveys.

Rare plant surveys were timed to optimize plant identification (e.g., during flowering and/or fruiting) and occurred during the summer of 2016 (July 4 to 8 and August 8 to 11). Survey efforts focused on sites where proposed infrastructure overlapped with potential rare plant habitat within the LSA. Outside of the LSA, rare plant surveys were conducted at select sites (based on professional opinion and site characteristics) that contain habitat with a greater likelihood of rare species to provide a regional context of plant and lichen species.

All surveys were conducted by Curtis Björk, a qualified botanist with extensive experience in the region. Surveys were conducted 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 containing rare species (US Department of the Interior 2009).

A full floristic survey was conducted for each site concurrent with the rare plant surveys. These inventories further support the understanding of rare plant distribution and ecology by providing better understanding of their habitats and plant associations.

5.7.3 Data Collection

The field botanist collected representative coordinates using GPS when a rare plant or lichen species was encountered. The habitat characteristics of the population were recorded, and a general population size was estimated using the standard BC CDC form (BC CDC 2017).

Voucher specimens of the rare species were collected for verification and were submitted to the University of British Columbia (UBC) herbarium. Voucher specimens were not taken from exceedingly small populations. Voucher species were compared against characteristic specimens and photographs in the UBC herbarium to ensure accurate species identification and to aid in detection when species are previously undescribed or not known to occur in a given region.

All taxa encountered were identified to the level of species or lower. Uncertain identifications were indicated in the Project species list either by a question mark, or as *cf.* (from the Latin for "compare against"). The cf. 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 is reported with a question mark. Uncertainty 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.

5.8 Invasive Plant Species

Invasive plants are considered to be those which have been moved from their native habitat to a non-native area where they are able to reproduce quickly and result in negative economic, ecological, or social impacts. Impacts may include changes to the local growing conditions such as reduction in light, moisture, nutrients, and space or changes to soil chemistry. Invasive species can also impact wildlife species by creating loss of natural habitat for native insect, bird, and mammal species or by reducing forage availability. Invasive species can reduce slope integrity and impact stability of slopes, hillsides, and shorelines. These invasive species generally have higher rates of reproduction, fewer natural predators, and have the ability to thrive in different environments and thus they are able to compete and crowd out native species.

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 (NWIPC 2017).

Presence/not detected level surveys for invasive plants were conducted throughout the study area in conjunction with the rare plant surveys and the 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* plant list in order to determine the presence of any invasive plants in the study area.

6. RESULTS

6.1 TERRAIN AND BIOTERRAIN MAPPING

Table 6.1-1 presents a summary of the spatial extent of surficial material types within the LSA and PFSA. Figure 6.1-1 shows where these materials occur within the LSA and Figures 6.1-2a through 6.1-2e show where they are within the PFSA. A detailed legend for surficial materials is provided in Appendix B. Definitions for surficial material and geomorphological processes (including geohazards) are located in Appendices C and D respectively. The March 29, 2017 Red Mountain Geophysical Report completed by SNC Lavalin provides results for terrain, terrain stability, natural hazards and soil erosion potential for the LSA (1:20,000 scale). The results for terrain, terrain stability, and soil erosion potential for the PFSA (1:5,000 scale) are outlined in this section.

Table 6.1-1 is a summary of the surficial materials mapped in the LSA and PFSA, and highlights the dominant material type in each polygon. Depending on the complexity of the terrain, each polygon may contain up to three surficial materials and each of these, although uncommon, may contain subsurface materials. As a result, geotechnical analyses and assessments must reference the terrain spatial database which contains the complete terrain information for each polygon.

Table 6.1-1. Summary of Surficial Materials Mapped in the LSA and PFSA

Surficial Material	Map Code	LSA		PFSA	
		Area (ha)	Percent	Area (ha)	Percent
Anthropogenic	A	1.5	0.0	24.1	2.5
Bedrock	R	2,346.1	14.8	96.5	10.0
Glaciocolluvial	CG	0.0	0.0	48.0	5.0
Colluvium	C	3,255.2	20.5	358.7	37.3
Fluvial	F	488.8	3.1	161.4	16.8
Glaciofluvial	FG	251.1	1.6	41.2	4.3
Ice	I	2,360.2	14.9	6.9	0.7
Moraine	M	5,342.5	33.7	221.1	23.0
Not Classified	NC	1,793.5	11.3	0.0	0.0
Organic	O	0.0	0.0	0.5	0.1
Undifferentiated materials	U	1.5	0.0	0.0	0.0
Water Features (small)	OW, PO, N	19.5	0.1	2.3	0.2
Total		15,859.9	100	960.7	100

The Bitter Creek watershed has undergone multiple glaciations. Currently, the watershed is undergoing rapid glacial retreat from the Little Ice Age. Based on trimlines visible on the available imagery, the

Bromley Creek glacier filled the Bitter Creek valley to about mid-slope during the peak of the Little Ice Age, and the surrounding Cambria Icefield likely covered the alpine. This interpretation is confirmed by vegetation distribution, where mature forests occupy mid slope positions while valley bottoms are occupied by young forests and pioneer vegetation. The glaciers deposited basal till and lateral moraine till across the landscape covering 23% of the PFSA. In other areas, glaciers scoured the underlying bedrock so that presently 10% of the PFSA consists of bedrock outcrops.

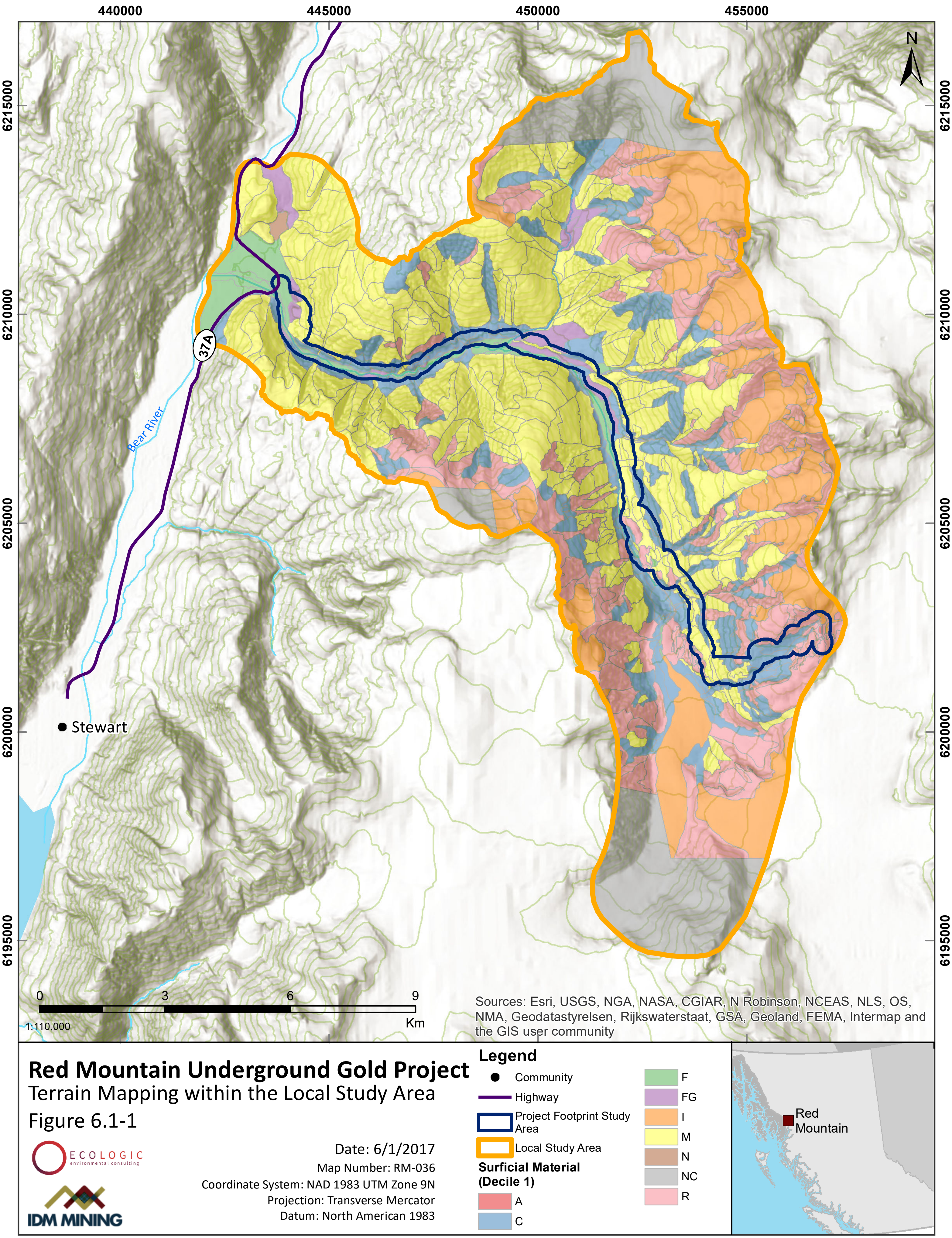
At some point during deglaciation, a glacial lake formed in the Bitter Creek valley bottom depositing glaciolacustrine sediments. This may have occurred when valley bottom ice in the Bear Creek Valley temporary blocked glacial melt flow from the Bitter Creek Valley. Glaciolacustrine sediments are mapped beneath younger colluvial sediments in the Bitter Creek Valley bottom between about a 3.5-km stretch centred on the mouth of Radio Creek. Because these sediments were not mapped at the ground surface, it does not appear in Table 6.1-1. However, it is important to highlight the presence of glaciolacustrine sediments as they make unstable foundations, fail at low angles, and are highly erodible.

During retreat of the valley glacier, ice-marginal glaciofluvial terraces and colluvial fans formed. Currently these landforms exist as terraces along the lower valley sides where glaciofluvial sediments form 4.3% and glaciocolluvial fans form 5.0% of the PFSA. These sediments are often useful sources for aggregate.

Recently deglaciated terrain is associated with a higher frequency and magnitude of landslides (rapid mass movements) than areas that have been ice free for millennia, due to debutressing of steep slopes and failure of poorly consolidated glacial sediments deposited on steep slopes (30% to 40%; Holm et al, 2004). Surficial materials moved by rapid mass movements such as debris slides, debris flows, debris torrents, and rockfall are classified as colluvium. Sediments moved by slow mass movement processes are classified as colluvium as well. Within the PFSA, this includes material deposited by bedrock slumps and sediments moved by solifluction and creeping ground ice in the alpine. Colluvium is the most extensive surficial material in the PFSA, covering 37.3%.

Fluvial sediments are mapped in the active floodplain and adjacent low-lying terraces of Bitter Creek and as fans on creeks with gentle gradients, such as Roosevelt Creek. Fluvial sediments make up 16.8% of the PFSA.

Polygons mapped as ice are uncommon (0.7%) in the PFSA and include the margins of the Cambria Icefield. In this young landscape, organic sediments are rare as well making up 0.1% of the landscape of the PFSA. Sediments modified and moved by humans are known as anthropogenic and cover 2.5% of the PFSA.



Red Mountain Underground Gold Project

Terrain Mapping within the Local Study Area

Figure 6.1-1

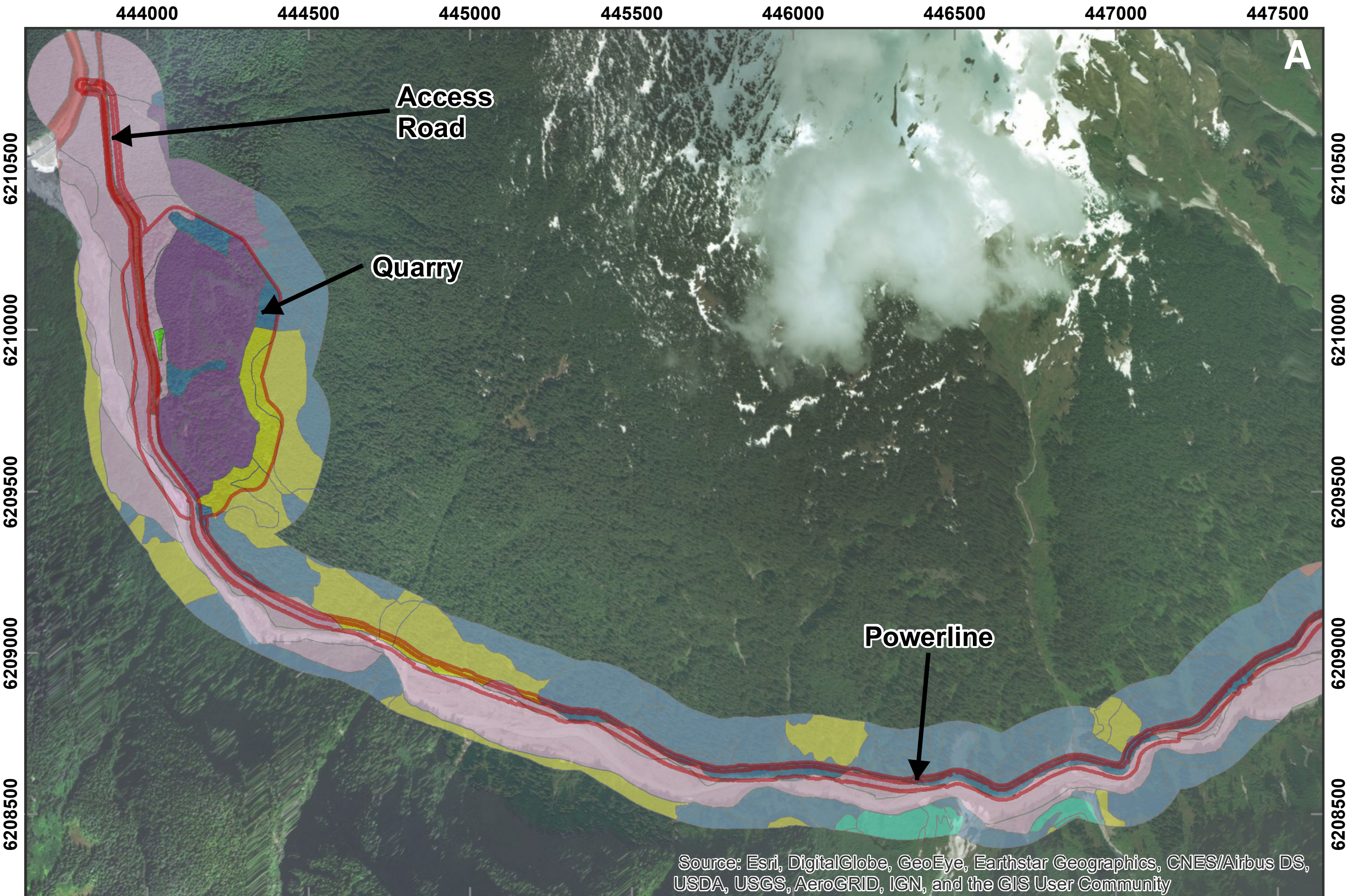
Date: 6/1/2017

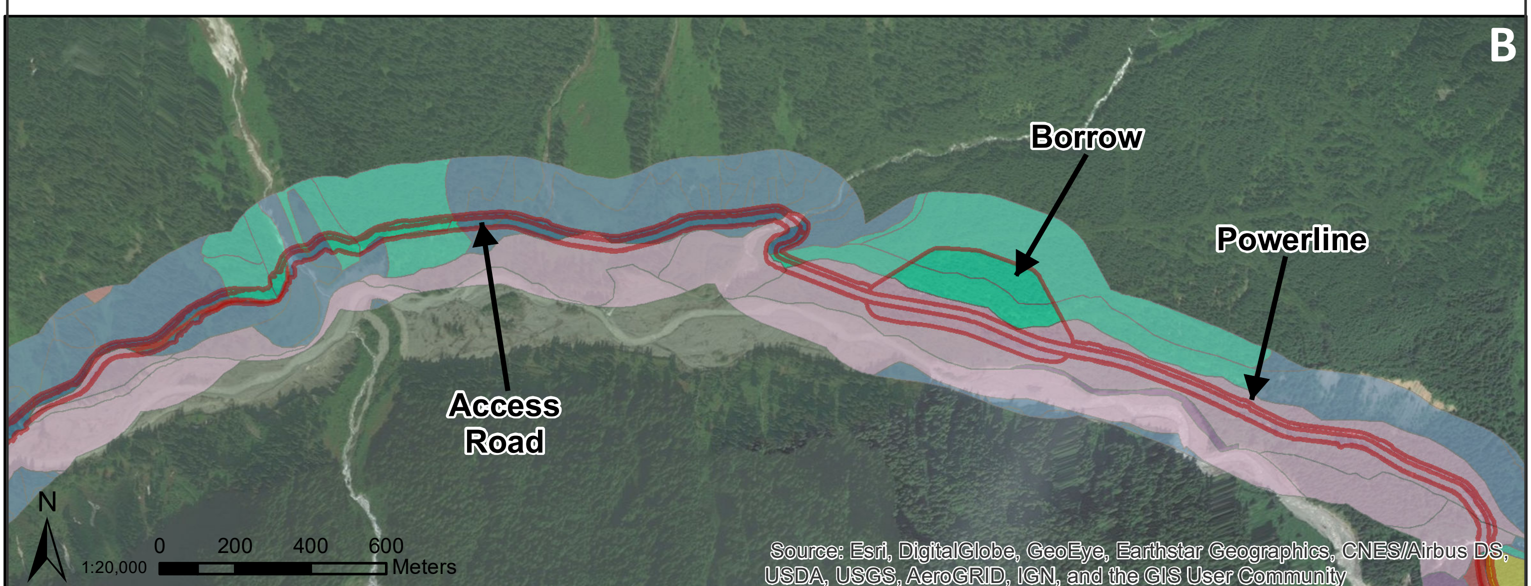
Map Number: RM-036

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983





Red Mountain Underground Gold Project

Terrain Mapping within the Project Footprint Study Area (Map 1 of 5)

Figure 6.1-2a

Date: 6/6/2017
Map Number: RM-037a
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

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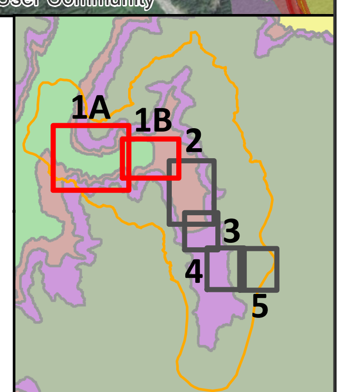
Legend

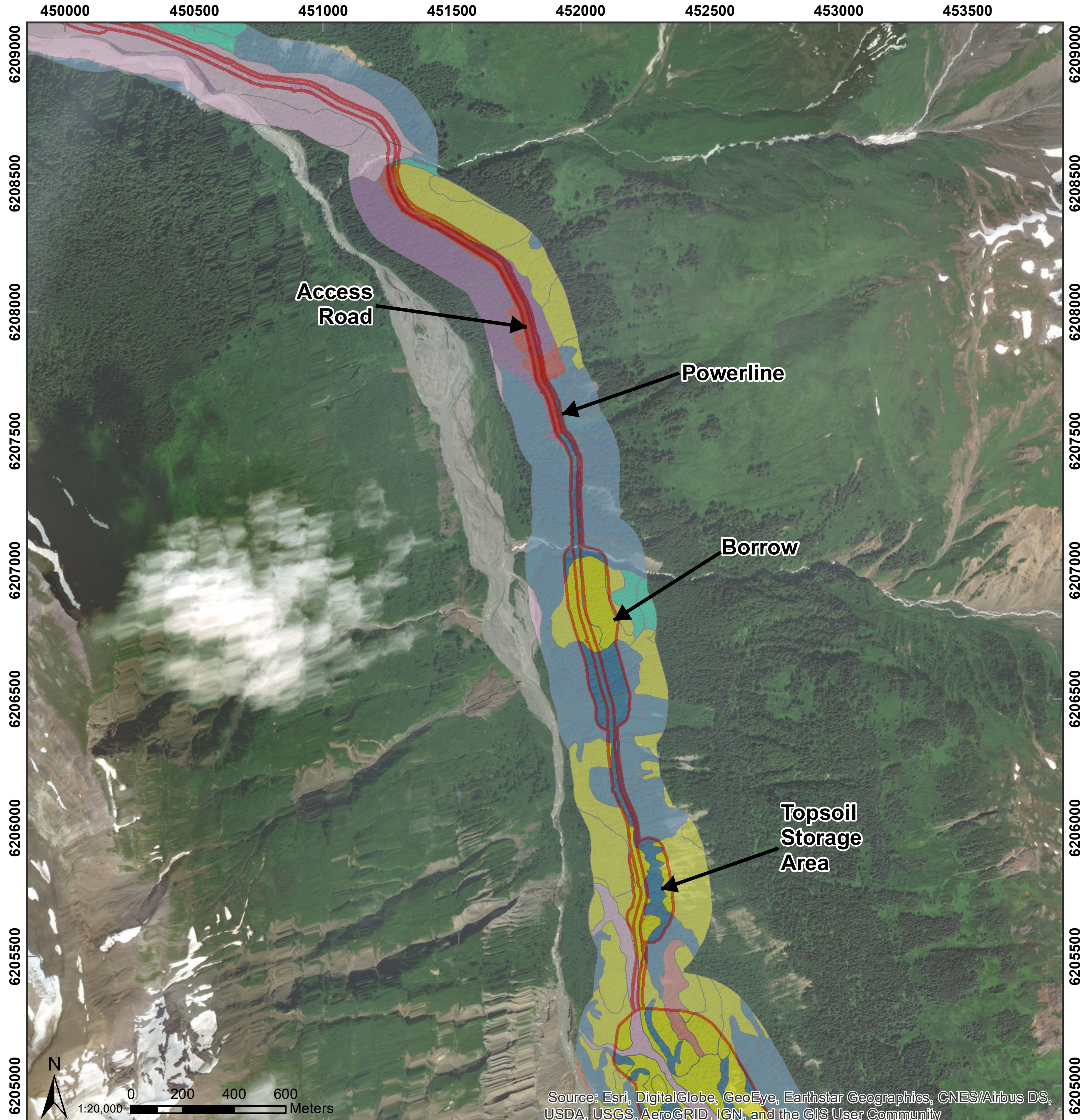
Effect

- Loss
- Alteration

Surficial Material (Decile 1)

- Anthropogenic (A)
- Colluvium (C)
- Glaciocolluvial (CG)
- Fluvial (F)
- Glaciofluvial (FG)
- Ice (I)
- Till; Morraine (M)
- Non-classified (N)
- Organic (O)
- Bedrock (R)





Red Mountain Underground Gold Project

Terrain Mapping within the Project Footprint Study Area (Map 2 of 5)

Figure 6.1-2b

Date: 6/6/2017

Map Number: RM-037b

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

IDM MINING

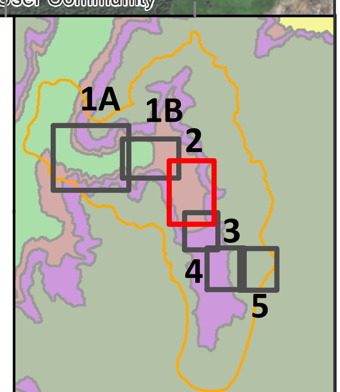
Legend

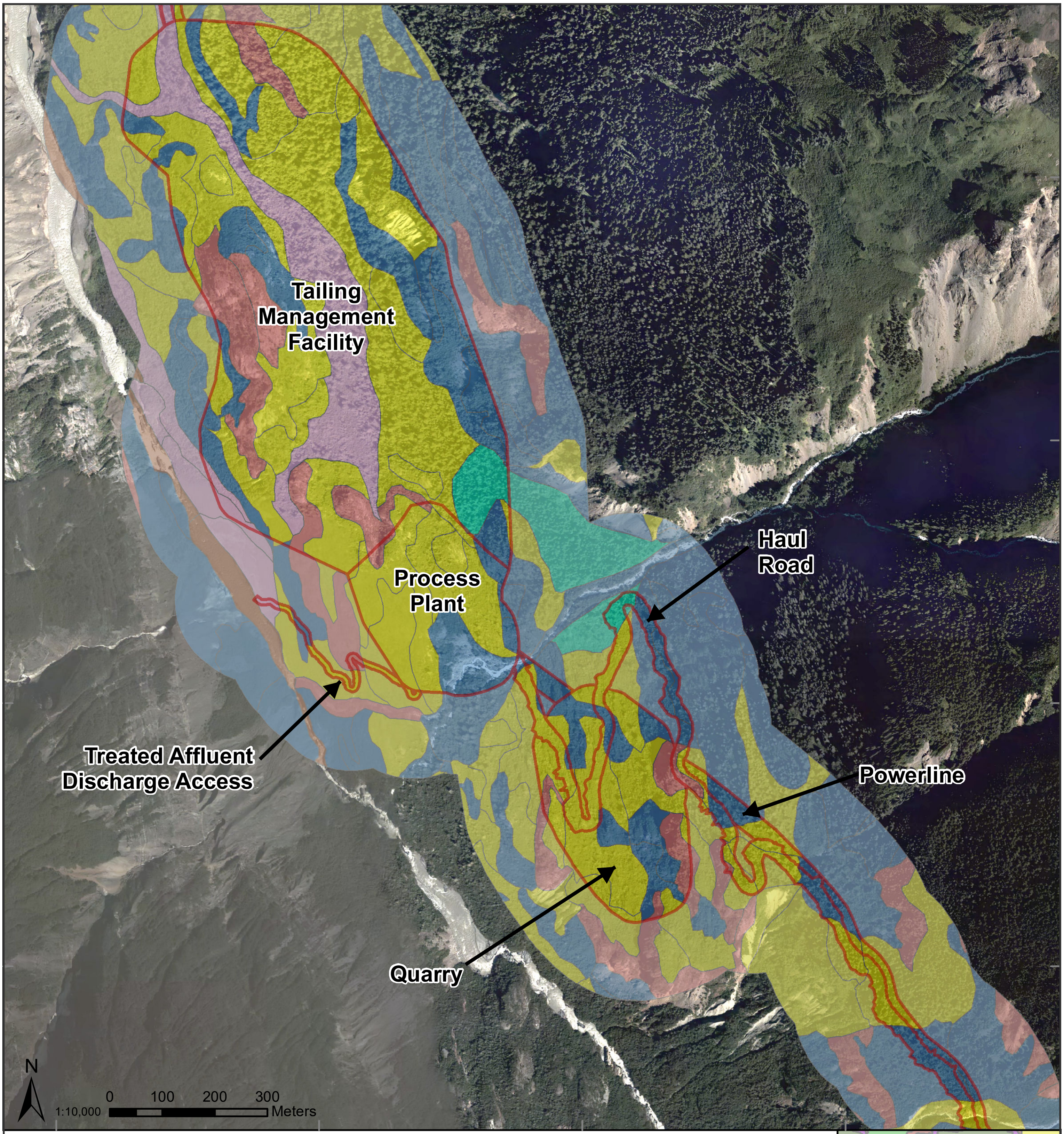
Effect

- Loss
- Alteration

Surficial Material (Decile 1)

- Anthropogenic (A)
- Colluvium (C)
- Glaciocolluvial (CG)
- Fluvial (F)
- Glaciofluvial (FG)
- Ice (I)
- Till; Morraine (M)
- Non-classified (N)
- Organic (O)
- Bedrock (R)





Red Mountain Underground Gold Project

Terrain Mapping within the Project Footprint Study Area (Map 3 of 5)

Figure 6.1-2c

Date: 6/6/2017

Map Number: RM-059c

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

IDM MINING

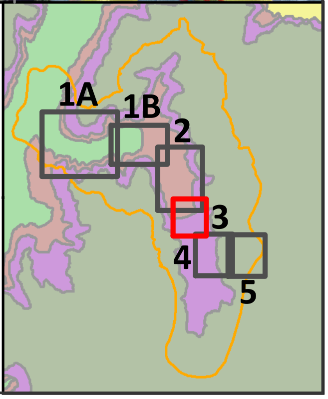
Legend

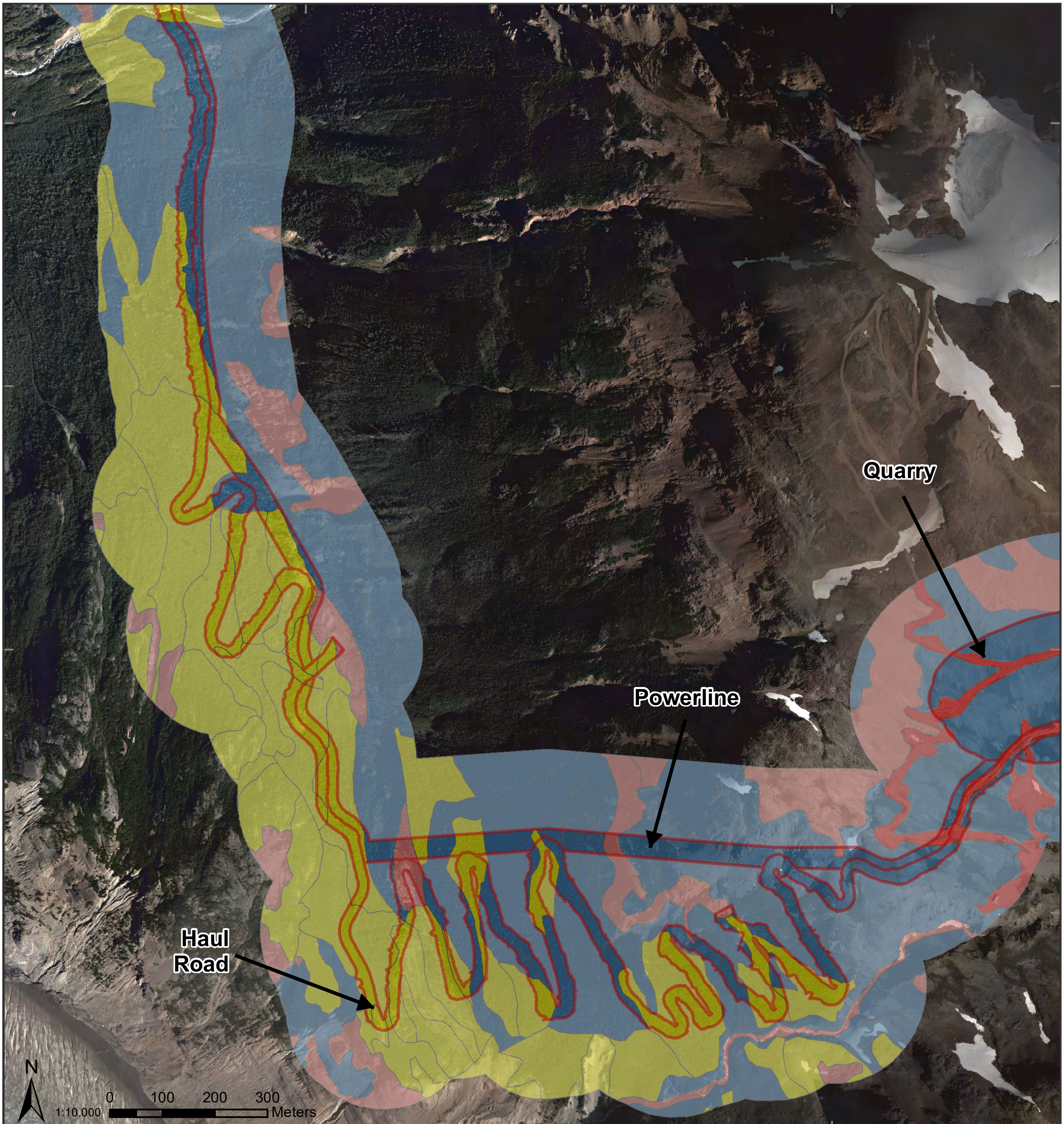
Effect

- Loss
- Alteration

Surficial Material (Decile 1)

- Anthropogenic (A)
- Colluvium (C)
- Glaciocolluvial (CG)
- Fluvial (F)
- Glaciofluvial (FG)
- Ice (I)
- Till; Morraine (M)
- Non-classified (N)
- Organic (O)
- Bedrock (R)





Red Mountain Underground Gold Project

Terrain Mapping within the Project Footprint Study Area (Map 4 of 5)

Figure 6.1-2d

Date: 6/13/2017
Map Number: RM-037d
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

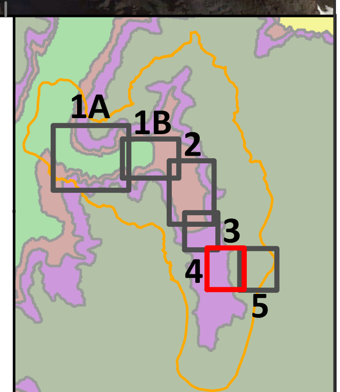
ECOLOGIC environmental consulting

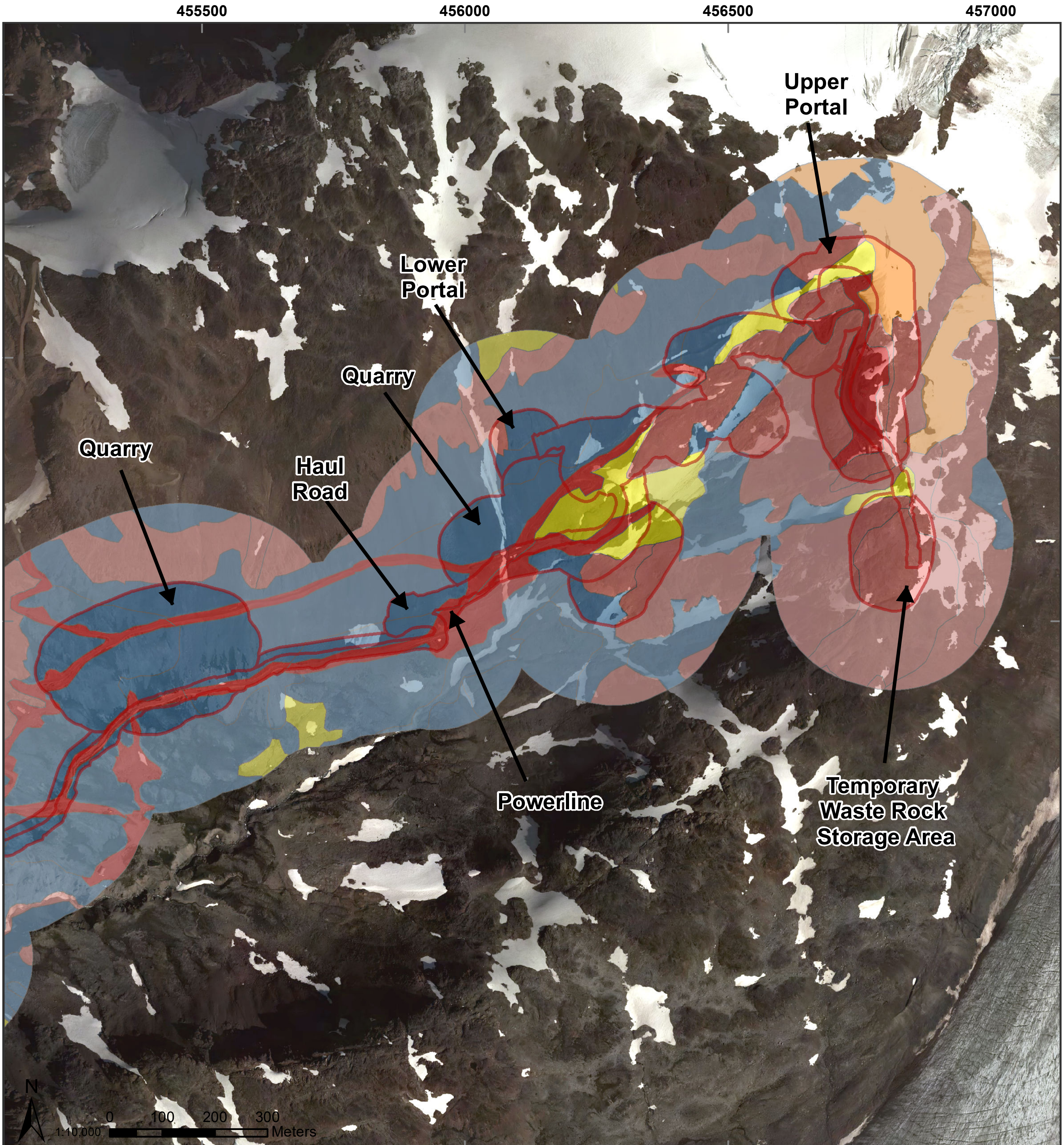
IDM MINING

Legend

Effect
- Loss
- Alteration

Surficial Material (Decile 1)
- Anthropogenic (A)
- Colluvium (C)
- Glaciocolluvial (CG)
- Fluvial (F)
- Glaciofluvial (FG)
- Ice (I)
- Till; Morraine (M)
- Non-classified (N)
- Organic (O)
- Bedrock (R)





Red Mountain Underground Gold Project

Terrain Mapping within the Project Footprint Study Area (Map 5 of 5)

Figure 6.1-2e

Date: 6/13/2017
Map Number: RM-037e
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting

IDM MINING

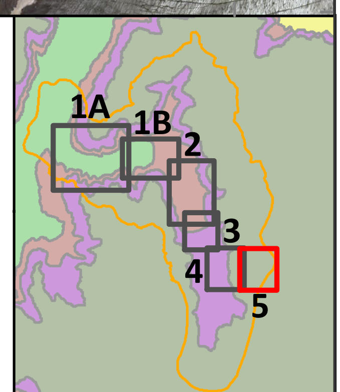
Legend

Effect

- Loss
- Alteration

Surficial Material (Decile 1)

- Anthropogenic (A)
- Colluvium (C)
- Glaciocolluvial (CG)
- Fluvial (F)
- Glaciofluvial (FG)
- Ice (I)
- Till; Morraine (M)
- Non-classified (N)
- Organic (O)
- Bedrock (R)



6.1.1 Geohazards

Polygons in the PFSA that have identified geohazards are presented in Figures 6.1-3a to 6.1.-3e. They include polygons that contain landslides, slumps, rockfall, and snow avalanches. The complete geohazard symbology is entered in the spatial database for each polygon (Appendix B). Table 6.1.-2 and Figure 6.1-1 show polygons that contain the presence of the following:

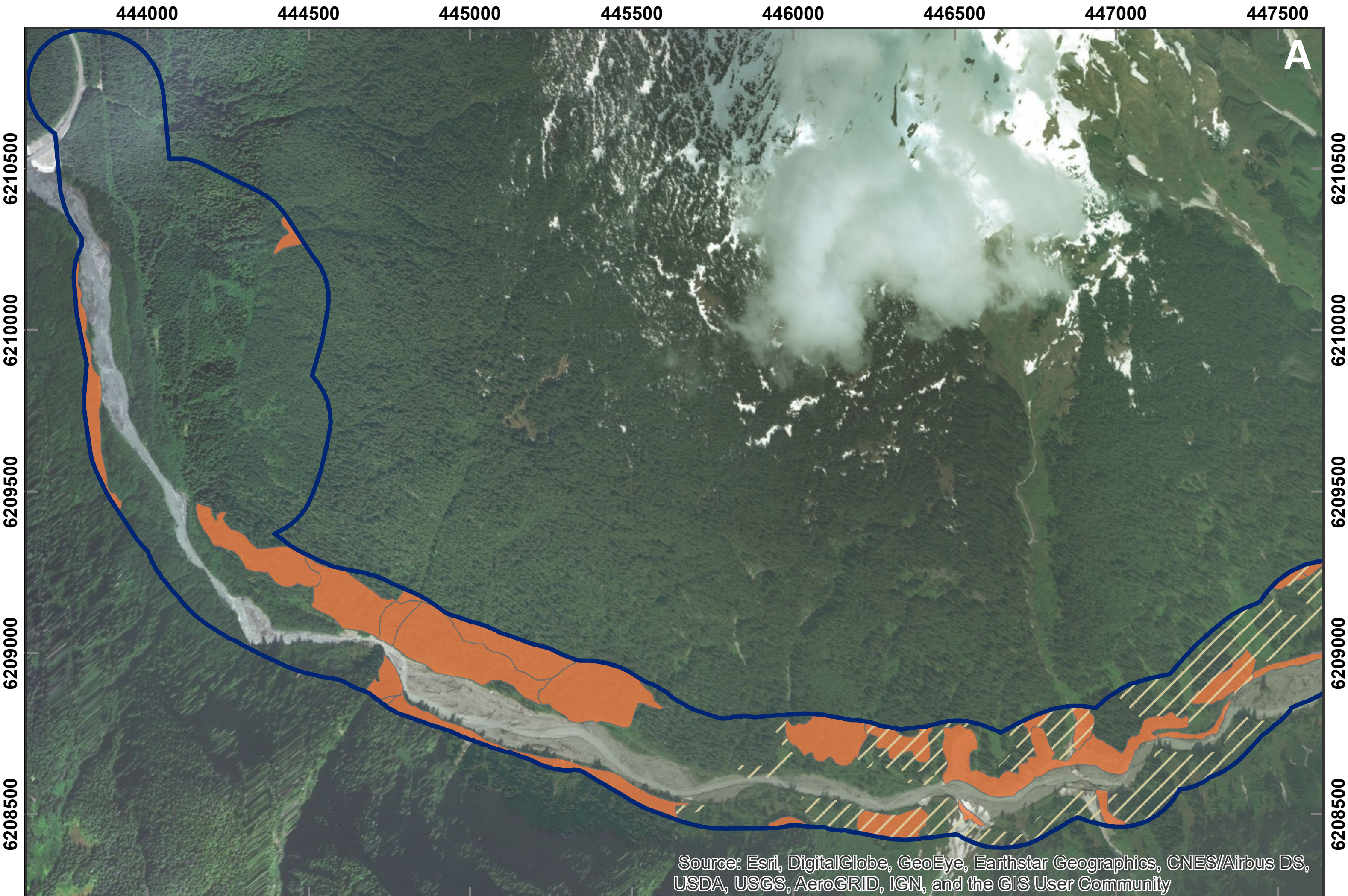
- Initiation zone of rapid mass movement processes, including, debris slide, debris flow, debris flood and rockfall);
- Initiation zone of slow mass movement processes, including, bedrock slumps, solifluction and ice/rock creep; and
- Snow avalanche.

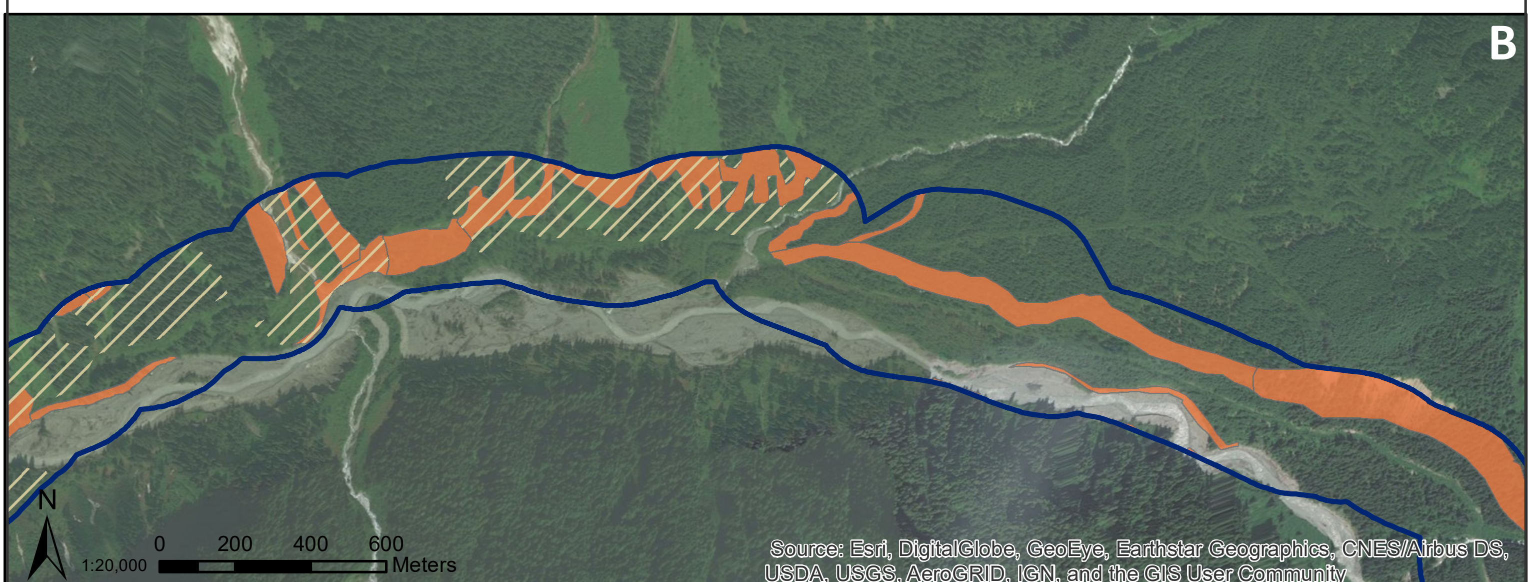
Rapid mass movement refers to downslope movement of debris derived from surficial material and/or bedrock. Where a double prime symbol (”) is used with a mass movement process (e.g., -R”s), slope failure has initiated within the polygon. Mass movement symbols without the double prime symbol (e.g., -Rb) indicate a polygon that contains the transport or deposition zone of rapid mass movement. Transportation zones are generally not recognized as areas where landslides initiate; however, they may contribute additional volume of transported material to a failure. Transport and deposition zones represent hazardous areas downslope of slides or rockfall. Figure 6.1-3 shows polygons containing the initiation zones only of rapid mass movement and slow mass movement processes.

Within the PFSA, 123 (22%) of the polygons contain the initiation zones of one or more rapid mass movement. These geohazards are spread throughout the PFSA and tend to occur on slopes steeper than 60%. Refer to the spatial geodatabase for the specific geohazard within a polygon. The spatial geodatabase also shows the polygons containing the transport and deposition zones of the geohazards.

Table 6.1-2. Summary of Geohazards and Snow Avalanches Mapped for the PFSA

Mass Movement Type	Geohazard Type	Map Code	No. of Polygons	Percent of Polygons
Rapid Mass Movement	Rockfall	-R”b	123	22.2
	Debris flow	-R”d		
	Debris slide	-R”s		
	Debris flood	-R”t		
Slow Mass Movement	Bedrock Slump	-F”m	39	7.0
	Solifluction	-S		
	Rock/ground ice creep	-F”g		
Snow Avalanche	Snow Avalanche	-A	106	19.1





Red Mountain Underground Gold Project

Geohazards Mapped within the Project Footprint Study Area

(Map 1 of 5)

Figure 6.1-3a

Date: 6/13/2017

Map Number: RM-065a

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

ECOLOGIC

Legend

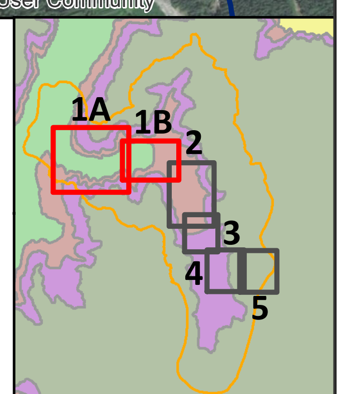
PFSA

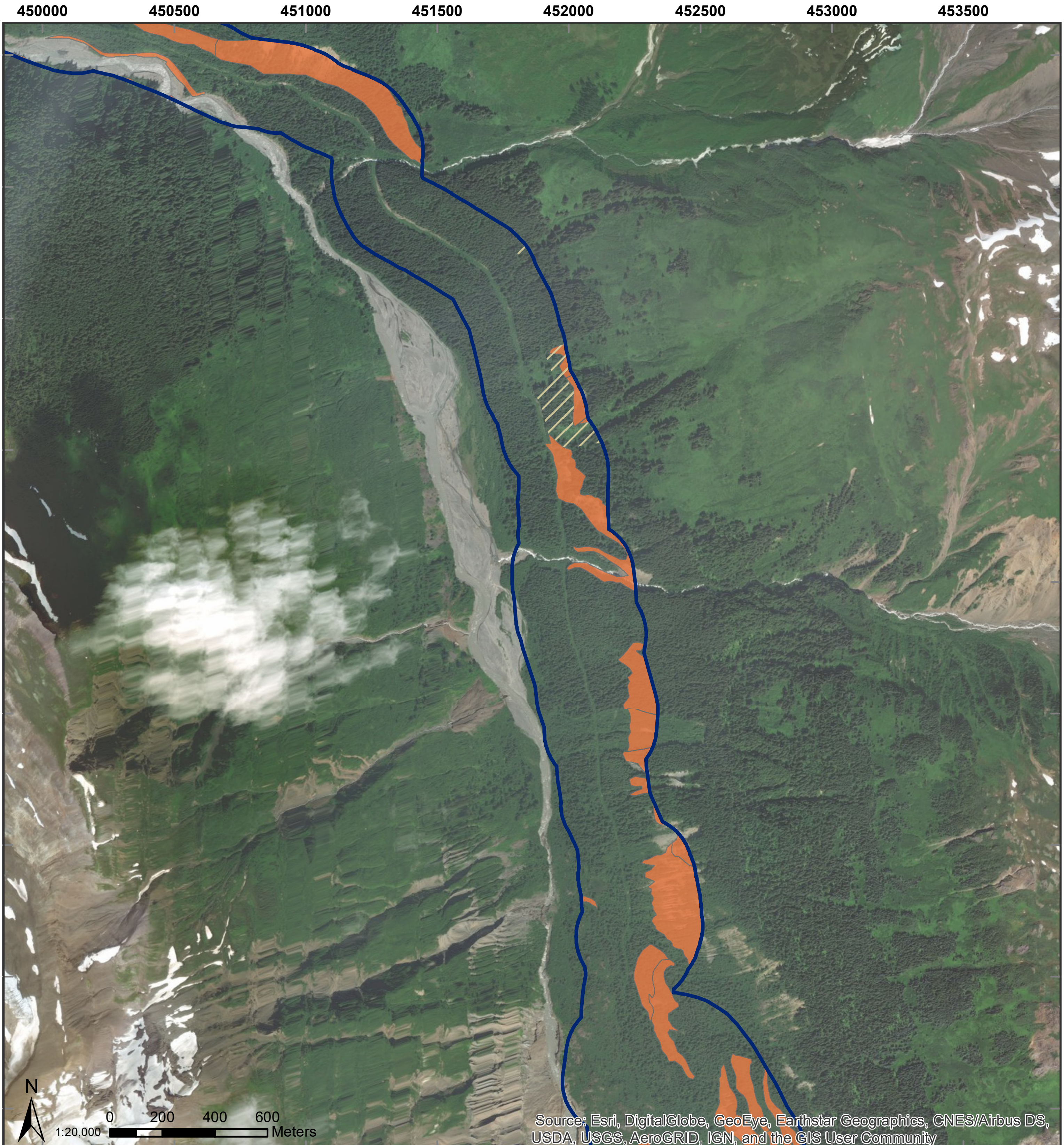
Geohazard Type

Rapid Mass Movement

Slow Mass Movement

Avalanche





Red Mountain Underground Gold Project

Geohazards Mapped within the Project Footprint Study Area

(Map 2 of 5)

Figure 6.1-3b

Legend

PFSA

Geohazard Type

Rapid Mass Movement

Slow Mass Movement

Avalanche

Date: 6/13/2017

Map Number: RM-065b

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

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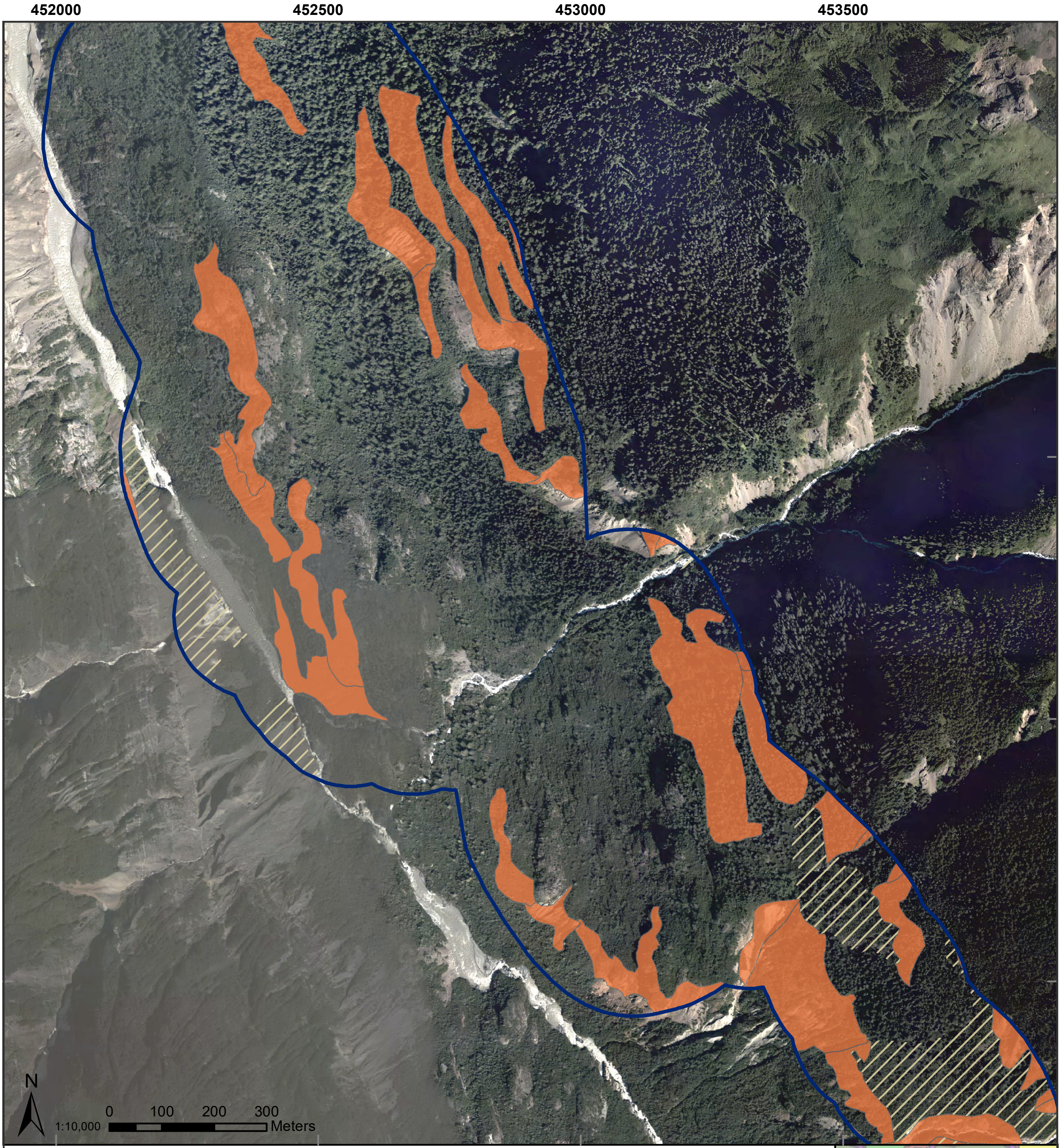

Red Mountain Underground Gold Project

Geohazards Mapped within the Project Footprint Study Area
(Map 3 of 5)
Figure 6.1-3c

Legend

PFSA

Geohazard Type

Rapid Mass Movement
Slow Mass Movement
Avalanche

Date: 6/13/2017
Map Number: RM-065c
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

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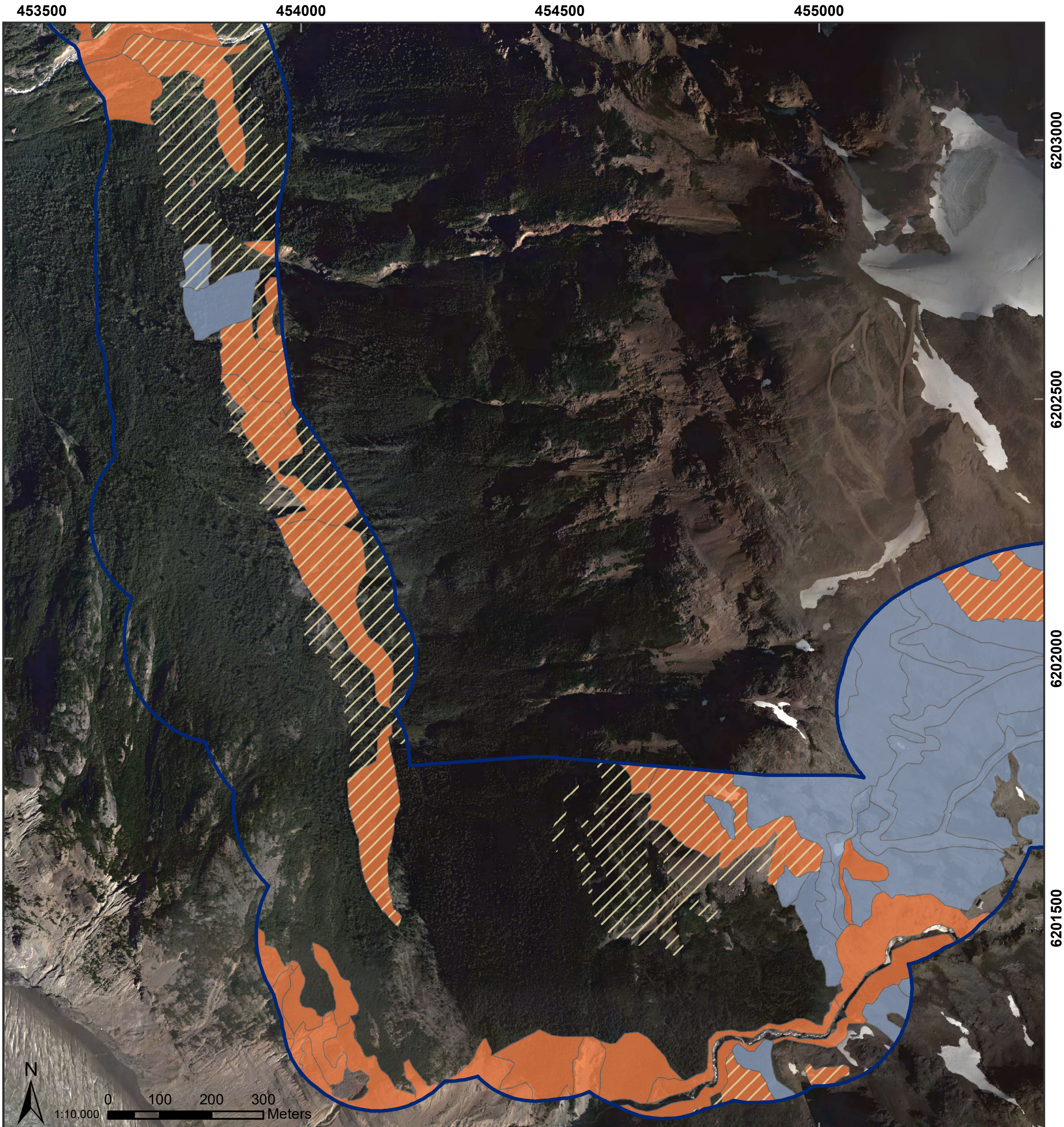


Red Mountain Underground Gold Project

Geohazards Mapped within the Project Footprint Study Area
(Map 4 of 5)
Figure 6.1-3d

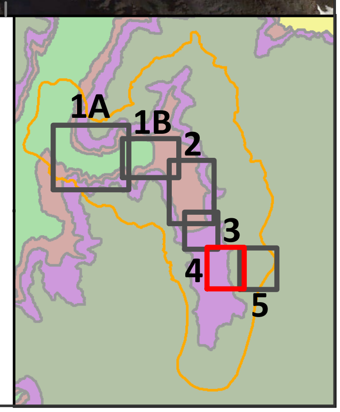
Date: 6/13/2017
Map Number: RM-065d
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

Legend

PFSA

Geohazard Type

Rapid Mass Movement
Slow Mass Movement
Avalanche



Red Mountain Underground Gold Project

Geohazards Mapped within the Project Footprint Study Area

(Map 5 of 5)

Figure 6.1-3e

Date: 6/13/2017
Map Number: RM-065e
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

ECOLOGIC environmental consulting

Legend

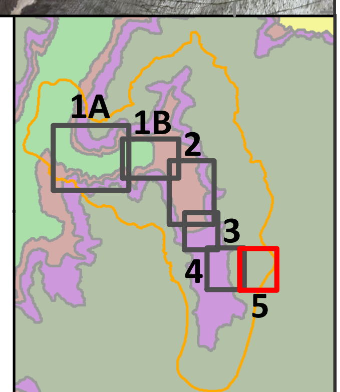
PFSA

Geohazard Type

Rapid Mass Movement

Slow Mass Movement

Avalanche



Polygons containing the initiation zones of slow mass movement processes occur in 39 (7%) of the PFSA polygons. Most of the polygons mapped with slow mass movement are located in the alpine area of Red Mountain and area associated with permafrost processes such as solifluction and larger lobate features created by creeping ground ice. A bedrock slump is mapped near the mouth of Rio Blanco Creek.

Snow avalanche is a common geomorphological process throughout the steep slopes of the PFSA, existing in 106 (19.1%) of the polygons. Polygons with snow avalanche are often located in polygons with rapid mass movement processes.

6.1.2 Terrain Stability

Terrain Stability maps for the PFSA are shown on Figures 6.1-4a through 6.1-4e. Table 6.1-3 shows the spatial extent of terrain covered by each of the five (5) terrain stability classes.

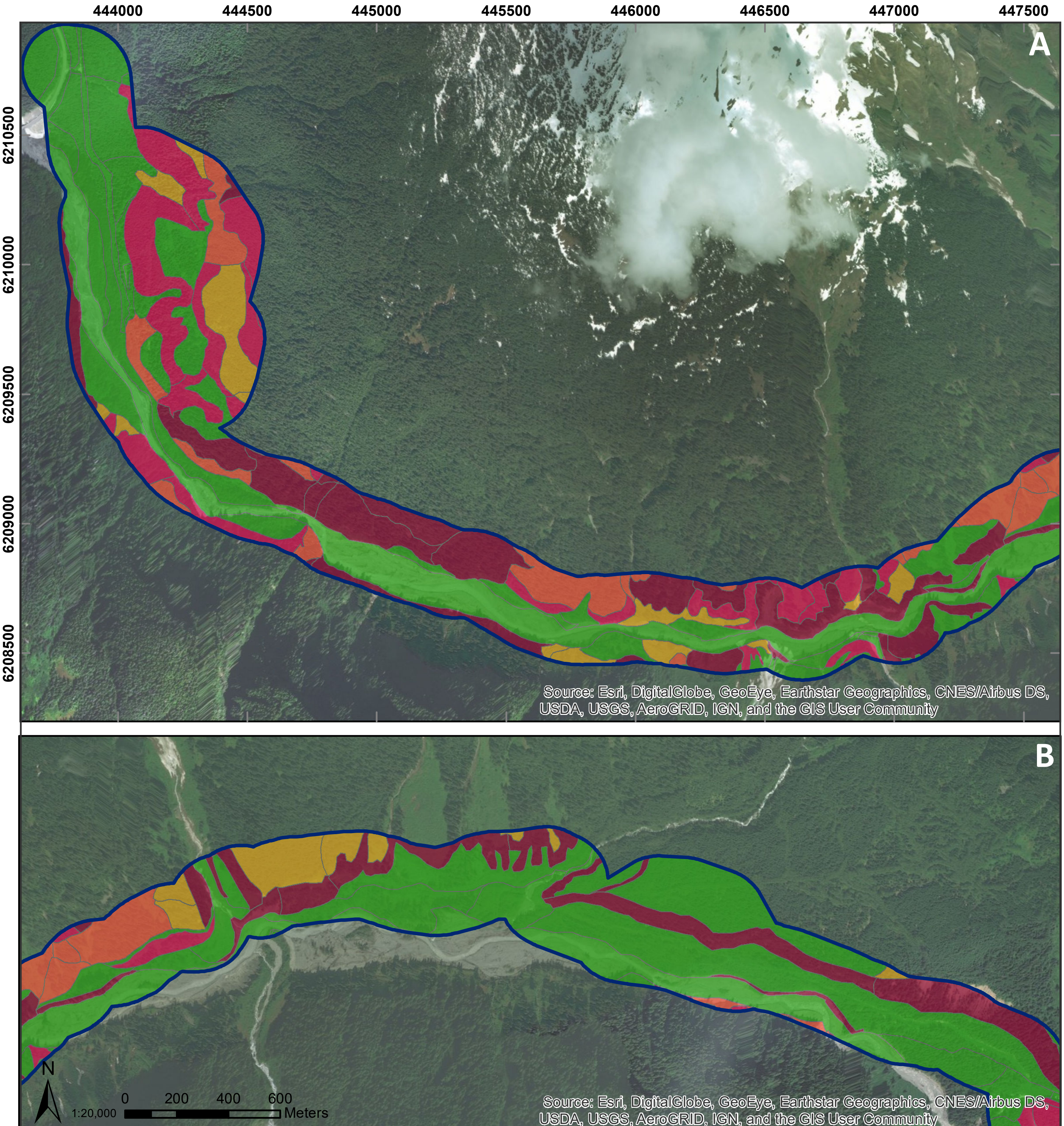
Table 6.1-3. Summary of Terrain Stability Mapped in the LSA and PFSA

Terrain Stability Class	Map Code	LSA		PFSA	
		Area (ha)	Percent	Area (ha)	Percent
Negligible	I	516.9	3.3	272.4	28.3
Very Low	II	1521.4	9.6	193.3	20.1
Low	III	2197.9	13.9	159.2	16.6
Moderate	IV	3345.5	21.1	124.3	12.9
High	V	4104.6	25.9	203.8	21.2
N/A	-	4173.6	26.3	7.9	0.8
Total		**15,859.9**	**100**	**960.7**	**100**

Polygons are mapped as unstable (TS class V) where the slopes show signs of terrain instability and include all polygons with initiation zones of rapid mass movement and slow mass movement geomorphological processes. Within the PFSA, 21.2% of the terrain is mapped as unstable.

Polygons that contain slopes greater than 50 to 60% and sloping terrain consisting of glaciolacustrine sediments that do not show signs of instability are classified as potentially unstable (TS class IV) and make up 12.9% of the PFSA. These polygons are scattered throughout the steeper slopes of the study area.

Terrain stability class I, II, and III is applied to most terrain with slopes less than about 60%. The percent coverage of each of these three classes is 28.3%, 20.1%, and 16.6% respectively. These polygons tend to occur along valley bottoms, terrace tops, the mouths of creeks, and on the hummocky terrain of the Bromley Humps.



Red Mountain Underground Gold Project

Terrain Stability within the Project Footprint Study Area

(Map 1 of 5)

Figure 6.1-4a

Date: 6/13/2017

Map Number: RM-062a

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

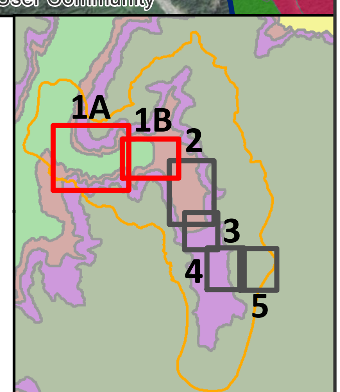
ECOLOGIC

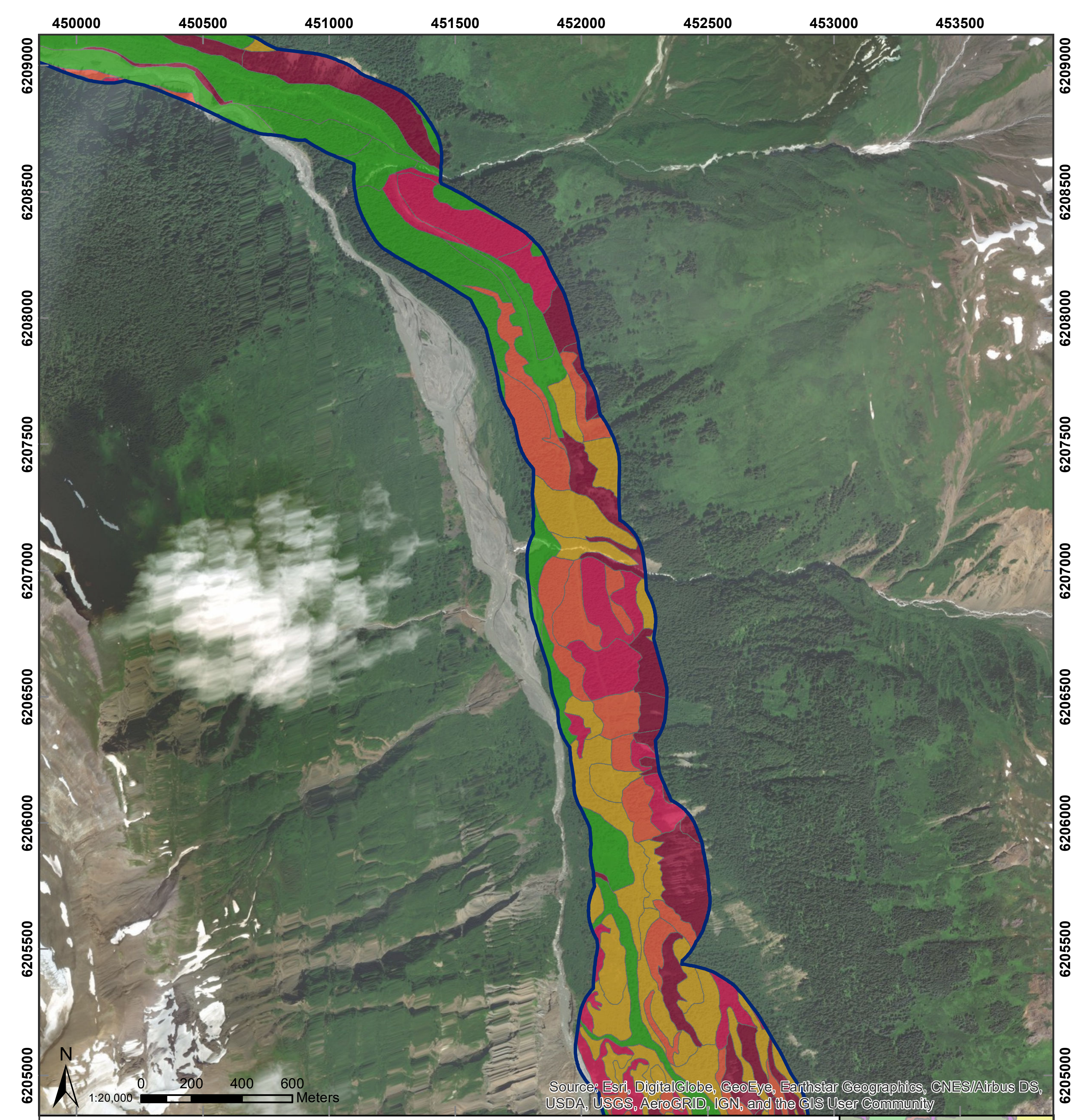
Legend

PFSA

Terrain Stability Class

- V - High
- IV - Moderate
- III - Low
- II - Very Low
- I - Negligible
- Not Applicable





Red Mountain Underground Gold Project

Terrain Stability within the Project Footprint Study Area

(Map 2 of 5)

Figure 6.1-4b

Date: 6/13/2017

Map Number: RM-062b

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

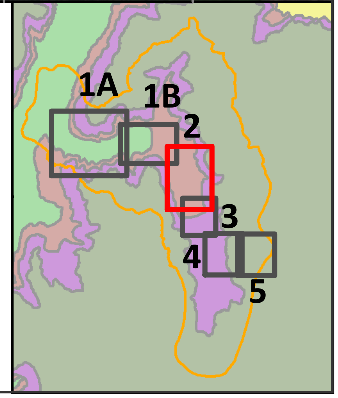
ECOLOGIC environmental consulting

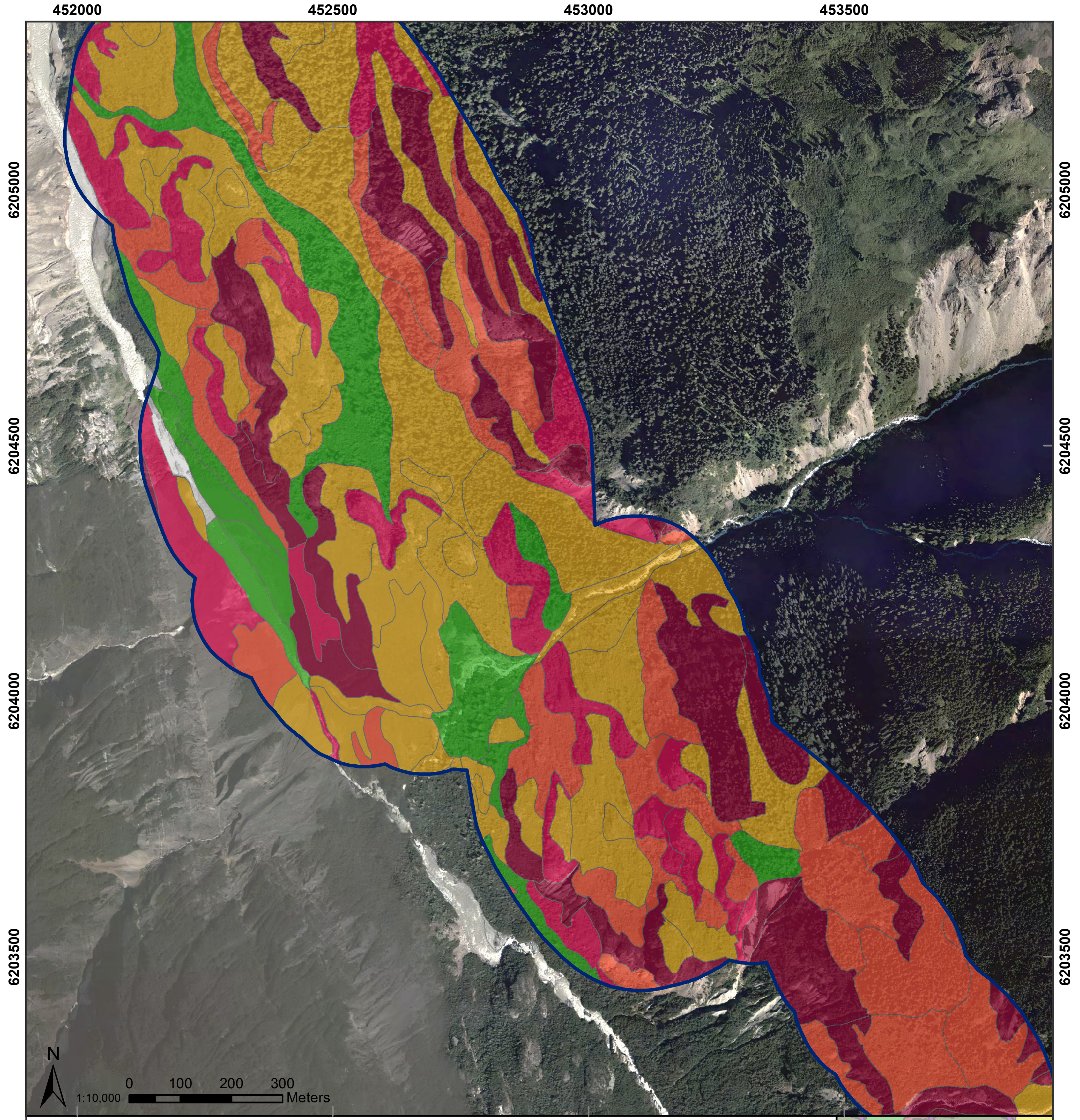
Legend

PFSA

Terrain Stability Class

- V - High
- IV - Moderate
- III - Low
- II - Very Low
- I - Negligible
- Not Applicable





Red Mountain Underground Gold Project

Terrain Stability within the Project Footprint Study Area (Map 3 of 5)

Figure 6.1-4c

Date: 6/13/2017
Map Number: RM-062c
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

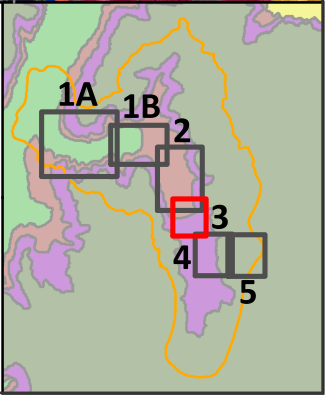
IDM MINING
ECOLOGIC

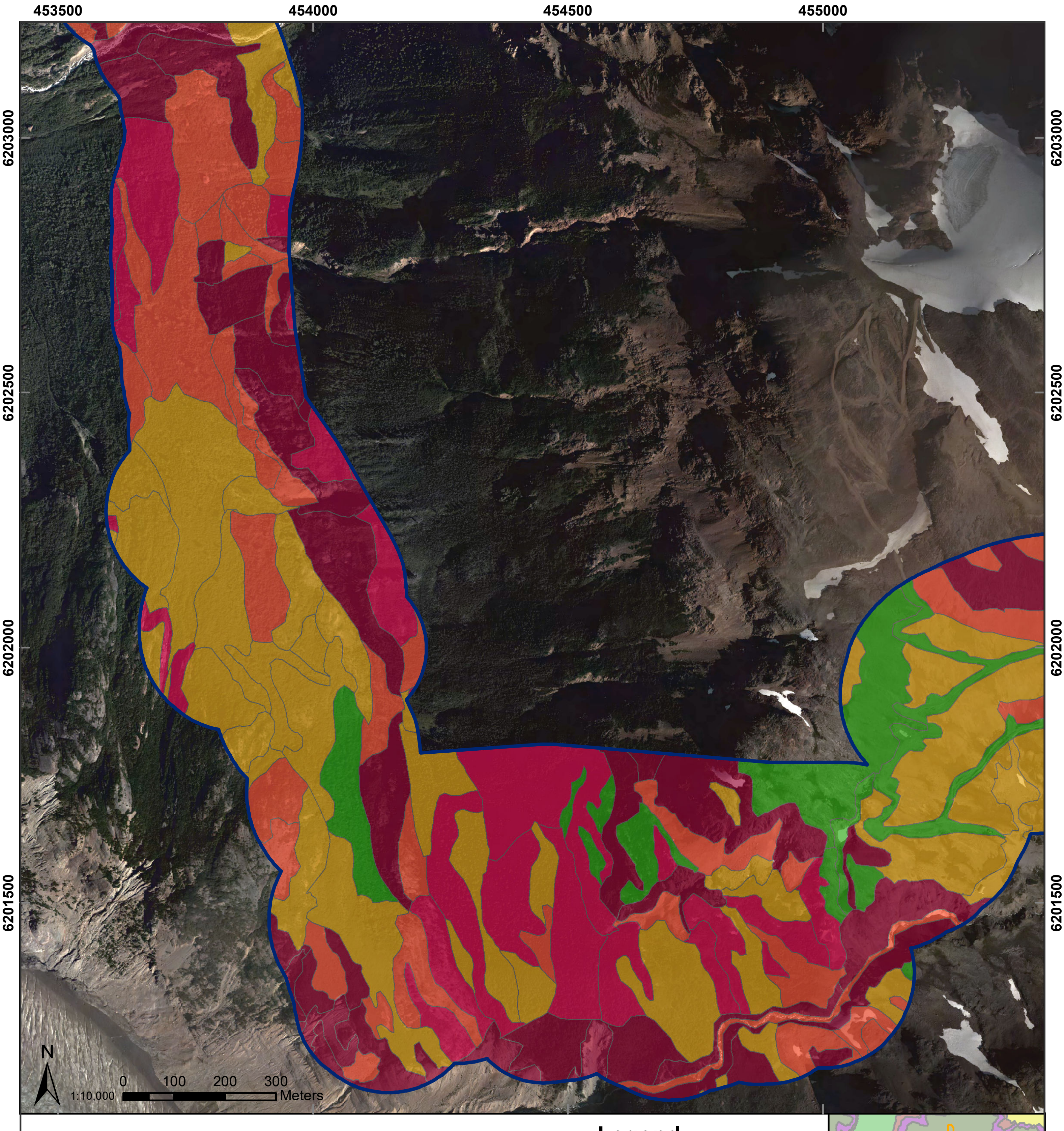
Legend

PFSA

Terrain Stability Class

- V - High
- IV - Moderate
- III - Low
- II - Very Low
- I - Negligible
- Not Applicable





Red Mountain Underground Gold Project

Terrain Stability within the Project Footprint Study Area
(Map 4 of 5)
Figure 6.1-4d

Date: 6/13/2017
Map Number: RM-062d
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

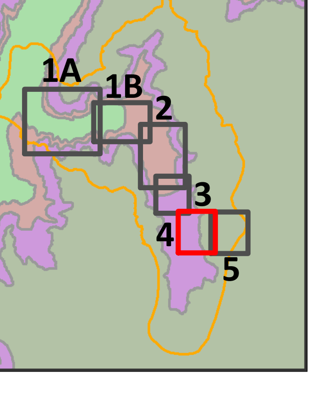
IDM MINING
ECOLOGIC environmental consulting

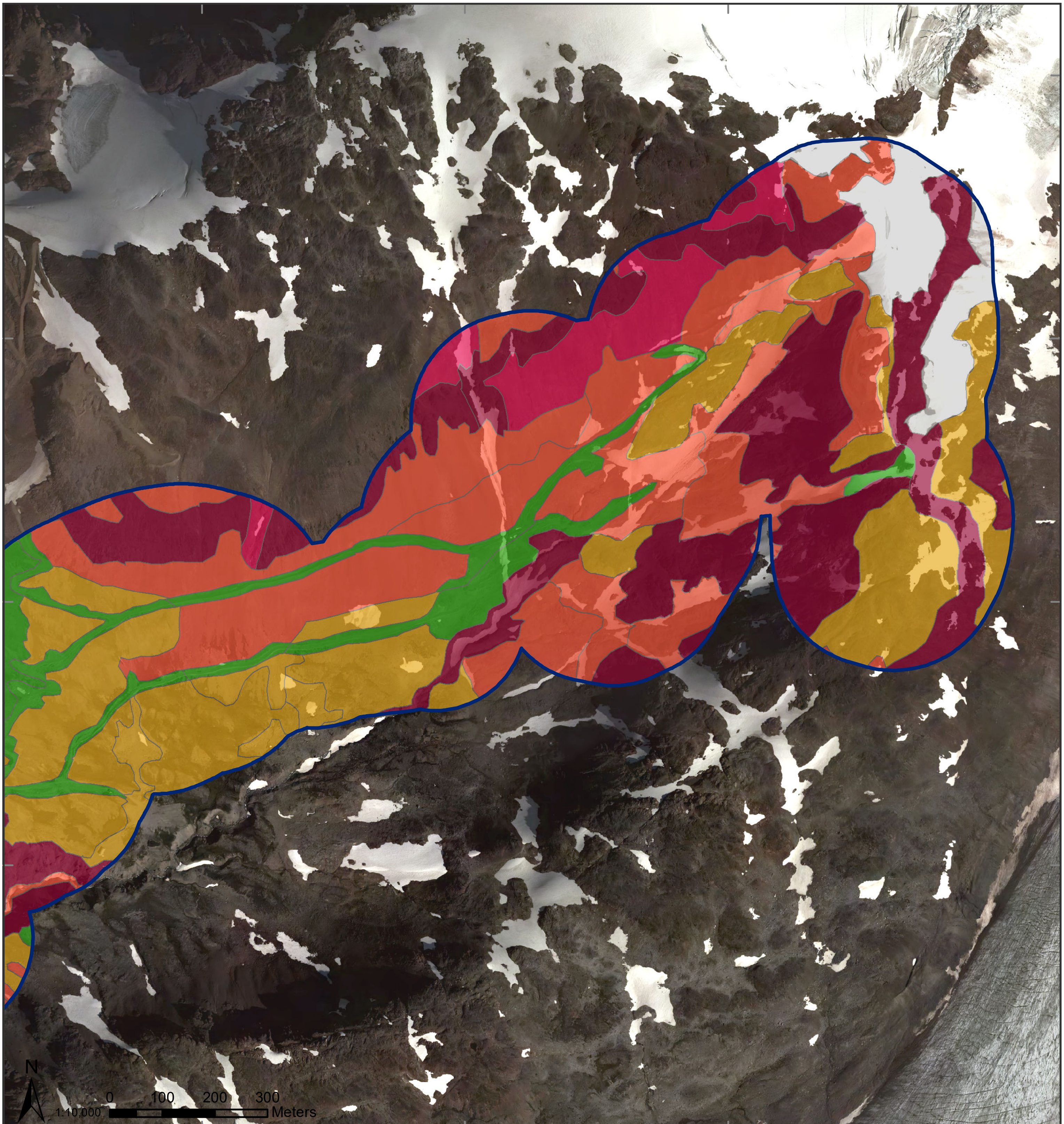
Legend

PFSA

Terrain Stability Class

- V - High
- IV - Moderate
- III - Low
- II - Very Low
- I - Negligible
- Not Applicable





Red Mountain Underground Gold Project

Terrain Stability within the Project Footprint Study Area

(Map 5 of 5)

Figure 6.1-4e

Date: 6/13/2017

Map Number: RM-062e

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

ECOLOGIC environmental consulting

Legend

PFSA

Terrain Stability Class

- V - High
- IV - Moderate
- III - Low
- II - Very Low
- I - Negligible
- Not Applicable

6.1.3 Soil Erosion Potential

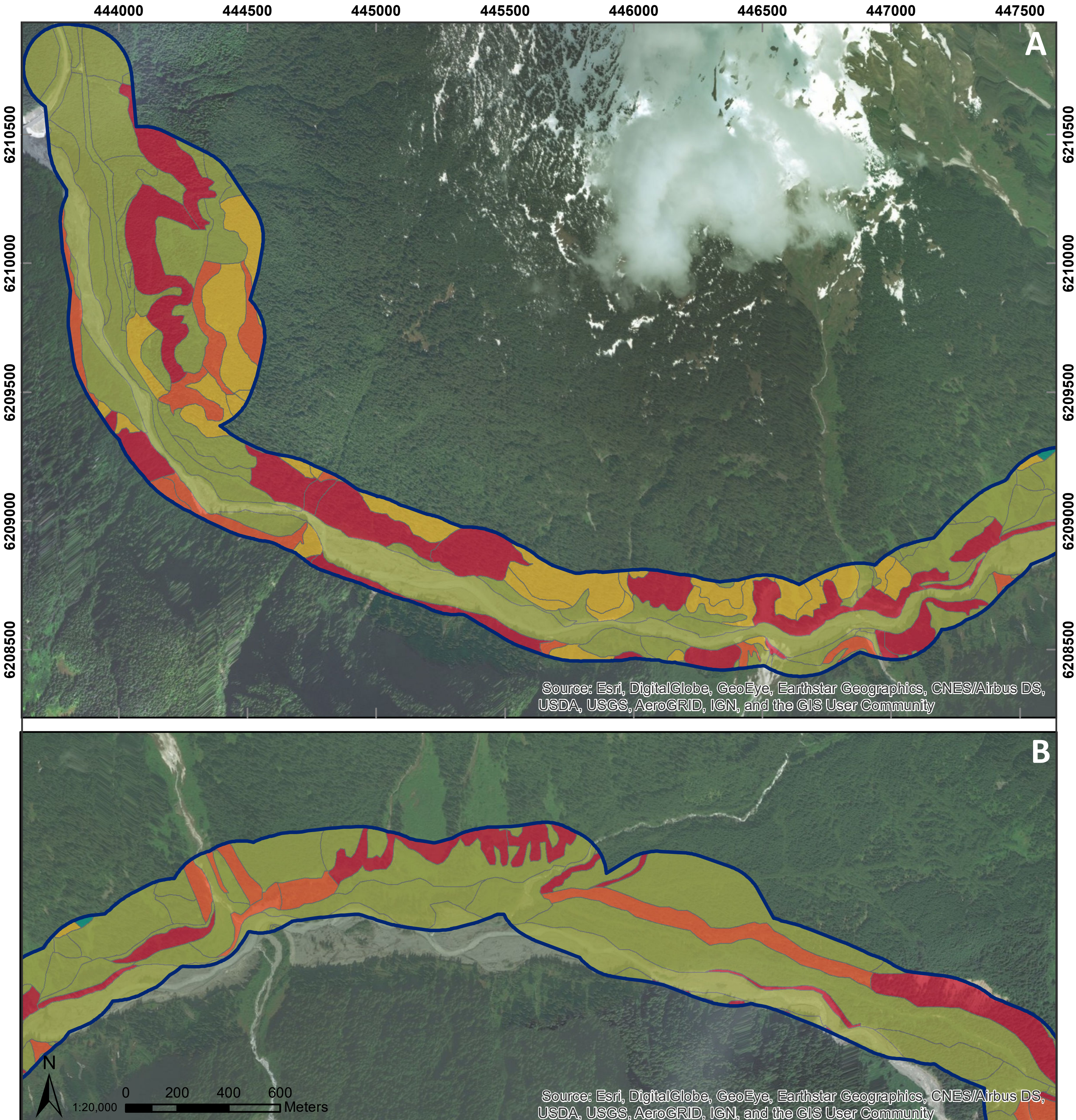
Soil Erosion Potential maps for the PFSA are presented in Figures 6.1-5a through 6.1-5e. Table 6.1-4 shows the spatial extent of terrain covered by each of the five soil erosion potential classes.

Table 6.1-4. Summary of Soil Erosion Potential Mapped in the PFSA

Soil Erosion Potential	Map Code	PFSA	
		Area (ha)	Percent
Very Low	VL	86.3	9.0
Low	L	454.3	47.3
Moderate	M	175.1	18.2
High	H	107.5	11.2
Very High	VH	129.7	13.5
N/A	-	7.9	0.8
Total		960.7	100.0

Very high SEP ratings are assigned to 13.5% of the terrain in the PFSA. Very high SEP ratings are assigned to surficial materials on gullied slopes greater than 40%. These polygons are scattered throughout the PFSA and include the failing lateral moraine sediments and many of the terrace escarpments in the lower valley sides (Plate 6.1-1). These moraine deposits are generally oversteepened, and will continue to fail until they achieve angle of repose.

Plate 6.1-1. Oversteepened moraine present along Roosevelt Creek



Red Mountain Underground Gold Project

Surface Erosion Potential within the Project Footprint Study Area

(Map 1 of 5)

Figure 6.1-5a

Date: 6/13/2017

Map Number: RM-057a

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

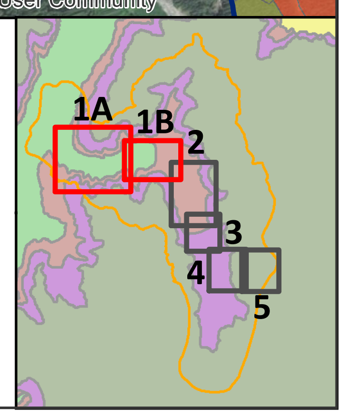
ECOLOGIC environmental consulting

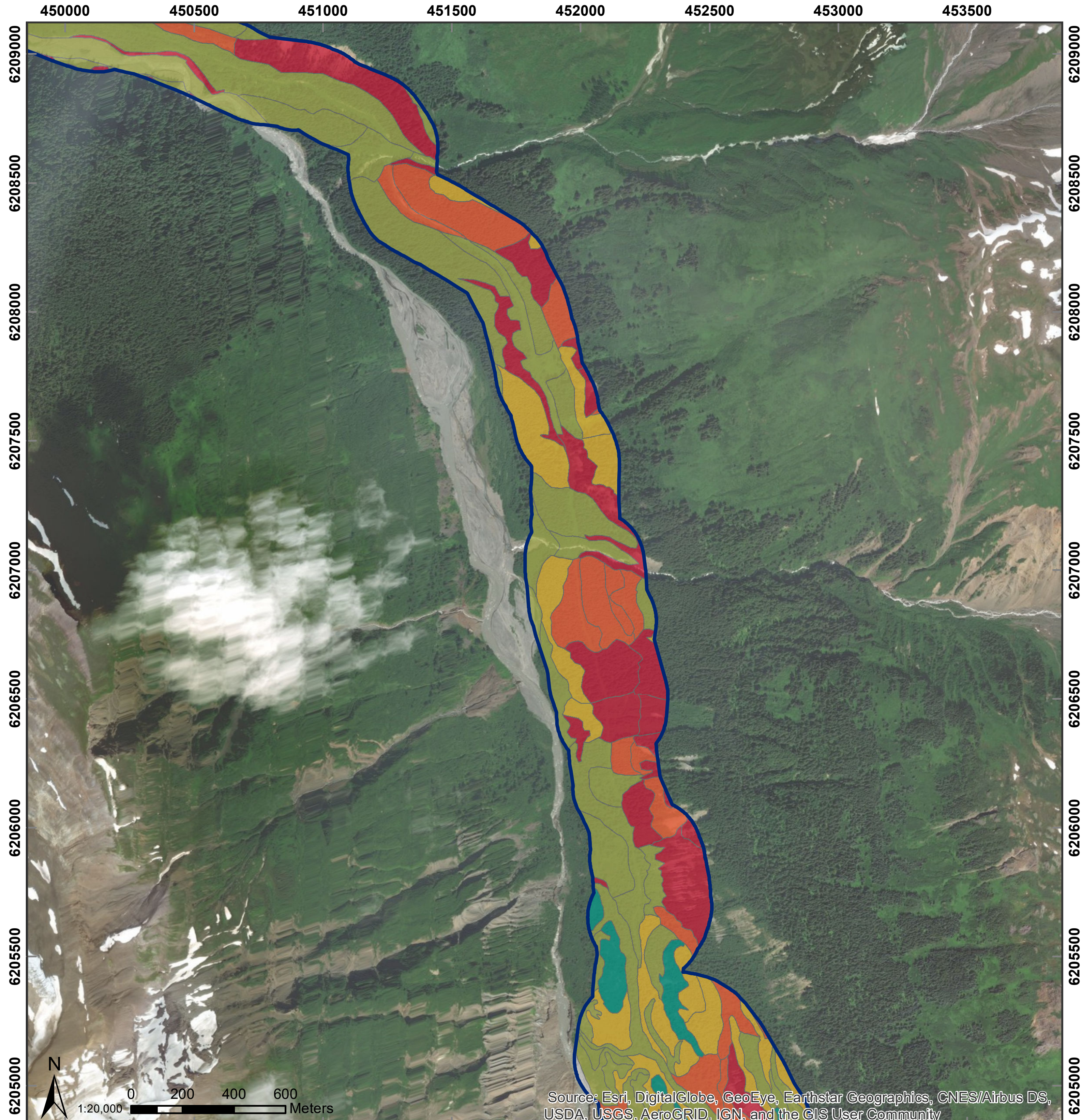
Legend

PFSA

Surface Erosion Potential

- Very High (VH)
- High (H)
- Moderate (M)
- Low (L)
- Very Low (VL)
- Not Applicable





Red Mountain Underground Gold Project

Surface Erosion Potential within the Project Footprint Study Area

(Map 2 of 5)

Figure 6.1-5b

Date: 6/13/2017
Map Number: RM-057b
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

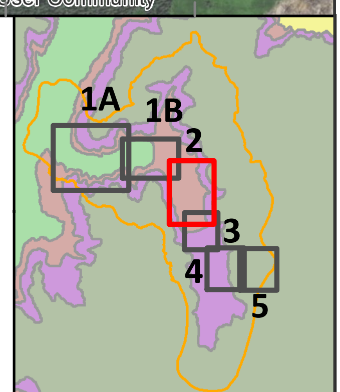
IDM MINING
ECOLOGIC environmental consulting

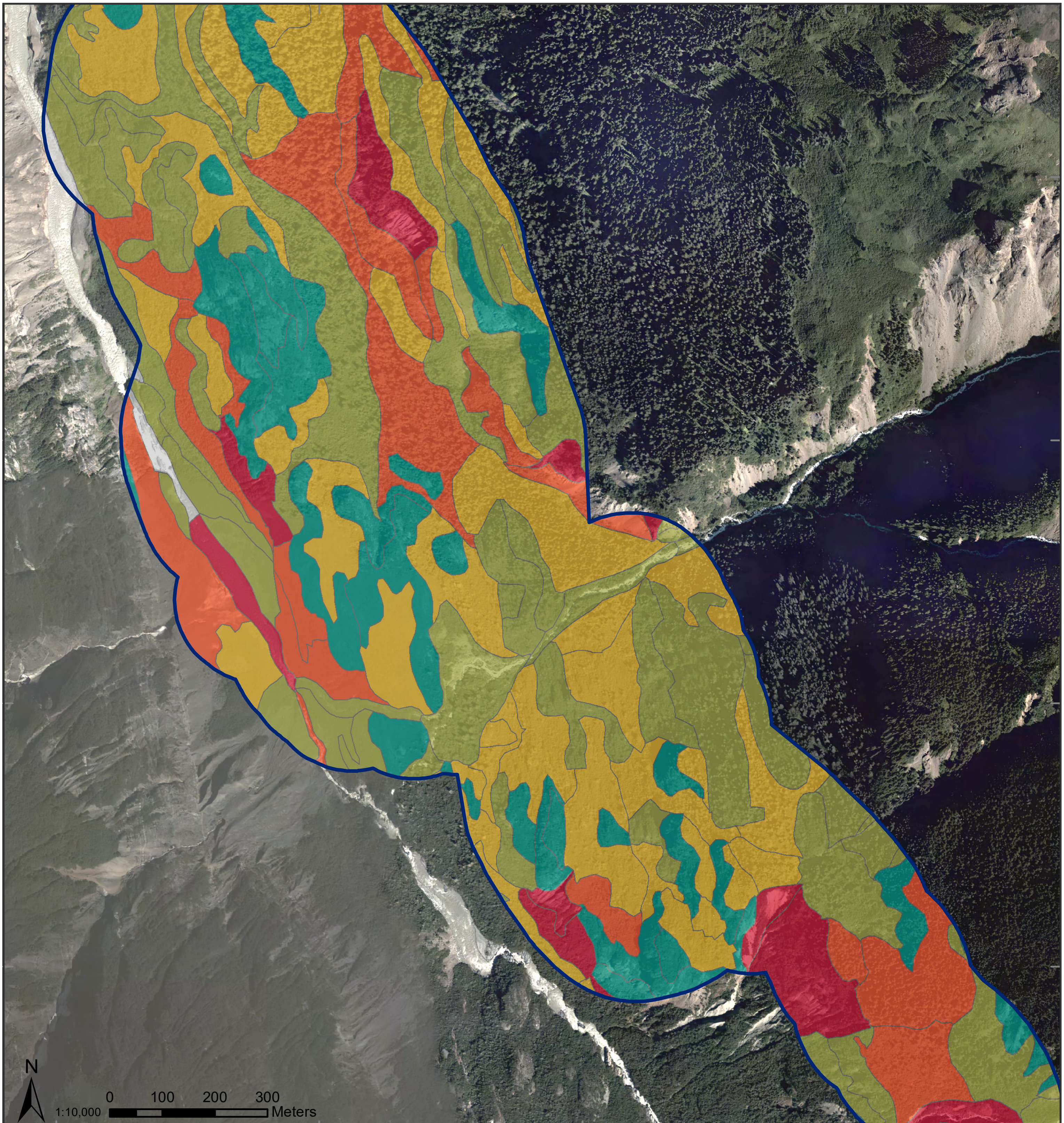
Legend

PFSA

Surface Erosion Potential

- Very High (VH)
- High (H)
- Moderate (M)
- Low (L)
- Very Low (VL)
- Not Applicable





Red Mountain Underground Gold Project

Surface Erosion Potential within the Project Footprint Study Area (Map 3 of 5)

Figure 6.1-5c

Date: 6/13/2017
Map Number: RM-057c
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

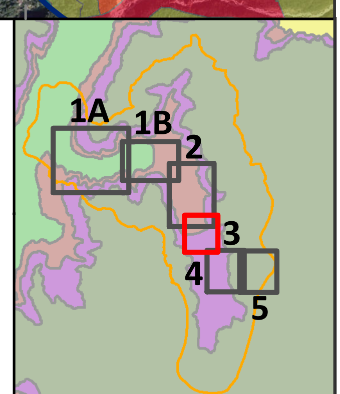
IDM MINING
ECOLOGIC

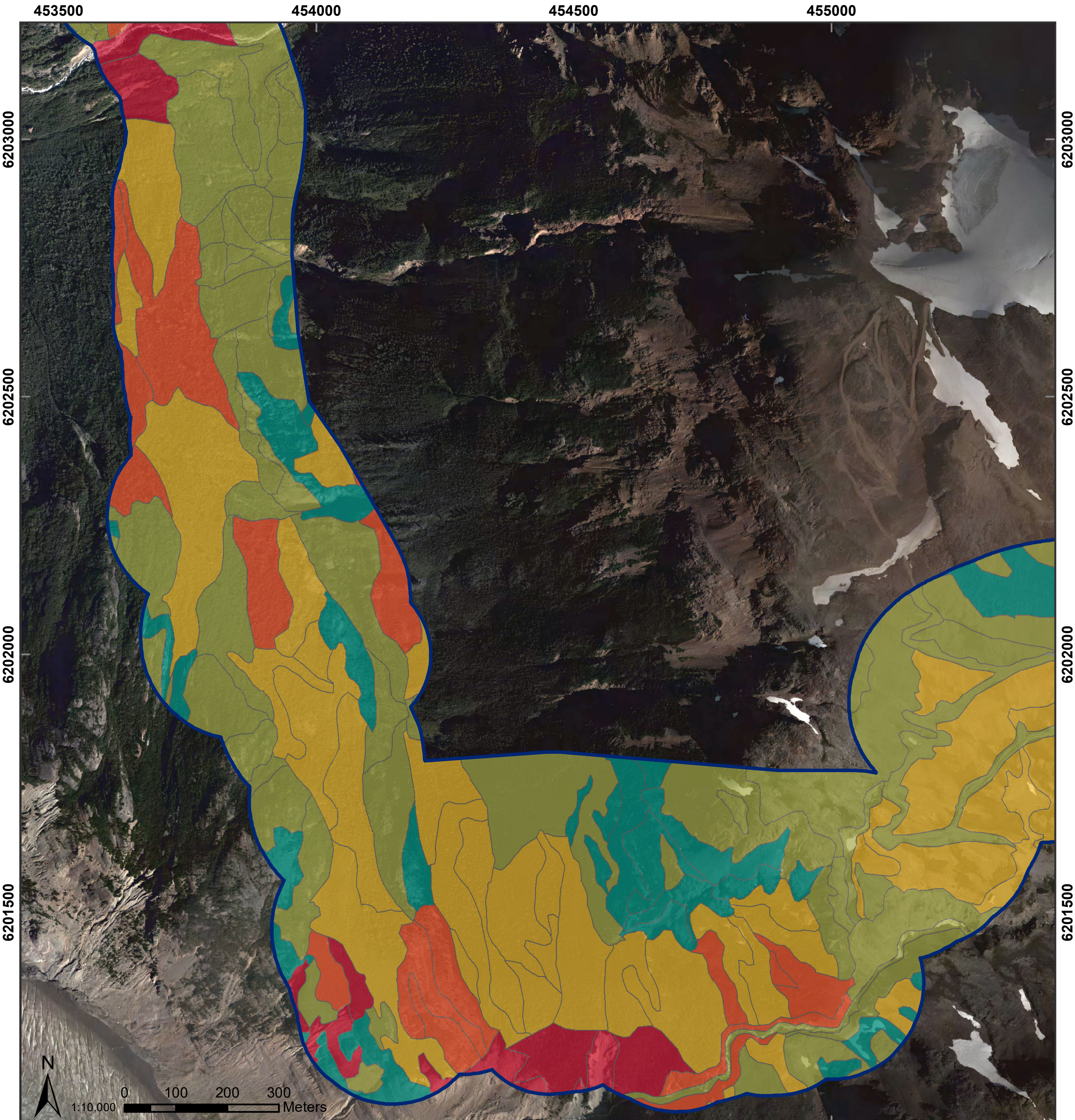
Legend

- PFSA

Surface Erosion Potential

- Very High (VH)
- High (H)
- Moderate (M)
- Low (L)
- Very Low (VL)
- Not Applicable





Red Mountain Underground Gold Project

Surface Erosion Potential within the Project Footprint Study Area

(Map 4 of 5)

Figure 6.1-5d

Date: 6/13/2017

Map Number: RM-057d

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

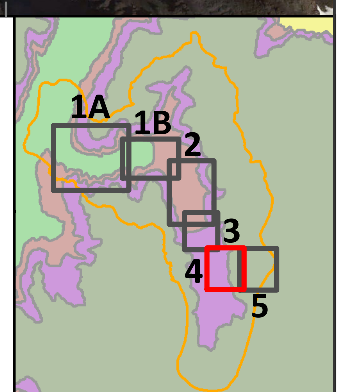
ECOLOGIC environmental consulting

Legend

PFSA

Surface Erosion Potential

- Very High (VH)
- High (H)
- Moderate (M)
- Low (L)
- Very Low (VL)
- Not Applicable



Red Mountain Underground Gold Project

Surface Erosion Potential within the Project Footprint Study Area

(Map 5 of 5)

Figure 6.1-5e

Date: 6/13/2017

Map Number: RM-057e

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

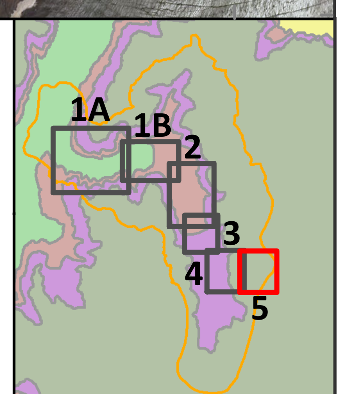
ECOLOGIC environmental consulting

Legend

PFSA

Surface Erosion Potential

- Very High (VH)
- High (H)
- Moderate (M)
- Low (L)
- Very Low (VL)
- Not Applicable



High SEP ratings are applied to 11.2% of the terrain. This rating is generally assigned to polygons with surficial materials on slopes greater than 40% that are not gullied. These polygons are scattered throughout the PFSA and largely consist of till and escarpments in glaciofluvial and glaciocolluvial sediments.

Moderate SEP ratings are assigned to 18.2% of the terrain. This rating is assigned to 1 m and thicker, matrix-supported surficial materials on gentler slopes as well as steeper slopes with less than 1-m thick surficial materials. This rating can be given to clast-supported surficial materials on slopes steeper than about 40%. Polygons with this classification are scattered throughout the PFSA.

Low SEP makes up 47.3% of the PFSA. This rating is assigned to clast supported and coarse-grained surficial materials on gentle slopes, such as cobbly and bouldery fluvial and colluvial sediments (floodplains and fans). Low ratings are given to talus slopes as well as any slope that has a discontinuous cover of thin or very thin surficial materials overlying bedrock. Polygons with this classification are scattered throughout the PFSA.

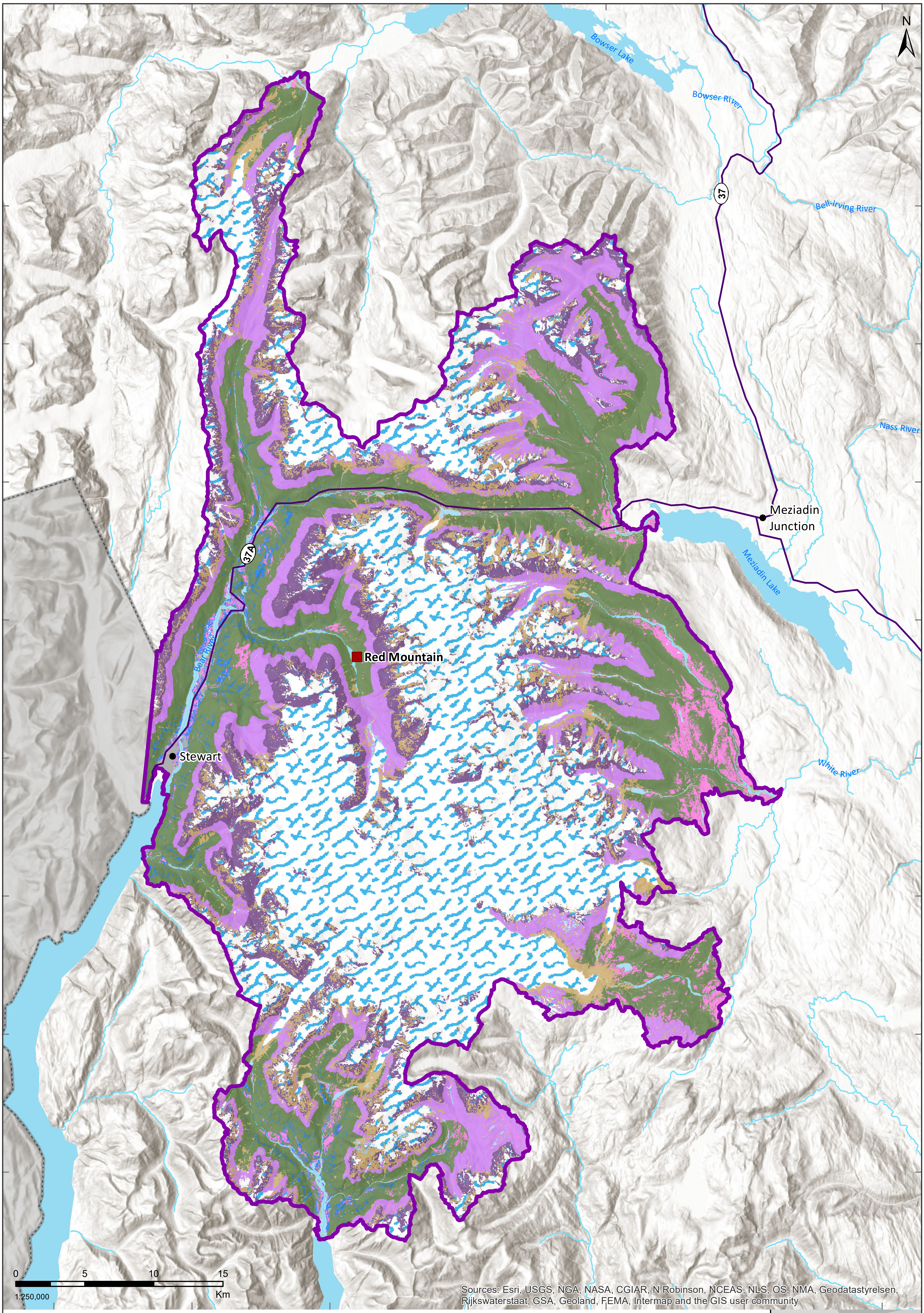
Very low SEP consists of 9% of the landscape. This is applied to polygons that consist mostly of bedrock, for example, scattered bedrock cliffs and ice-scoured bedrock on the Bromley Humps and in the alpine of the PFSA.

6.2 Ecosystem Mapping

The PEM (Figure 6.2-1) included six BEC units (Table 6.2-1), including coastal, interior and alpine areas. Alpine (CMAun) and parkland (MHmmp) zones covered over 70% of the RSA, with the remainder including subalpine forested units (16%) and lowland interior (5%) and coastal (8%) forested units. The LSA was mapped using traditional TEM methods at a scale of 1:20 000, while the PFSA was mapped at a scale of 1:5 000. The LSA (Figures 6.2-2a through 6.2-2d; Table 6.2-1) and PFSA TEM included CMAun (51.8% of the LSA and 17.2% of the PFSA), CWHwm (12.4% of the LSA and 36.7% of the PFSA), MHmm1 (14.3% of the LSA and 25.0% of the PFSA) and MHmmp (21.5% of the LSA and 21.1% of the PFSA) subzones.

6.2.1 Coastal Mountain-heather Alpine - Undifferentiated Subzone

The CMAun occurs at high elevations on the coastal mountains, as well as Vancouver Island and Haida Gwaii. This zone is a very wet environment with a deep and persistent snowpack which extends to lower elevations than other BEC alpine zones, resulting in the occurrence of alpine ecosystems at a lower elevation than interior zones. While extensive, much of the zone is characterized by largely barren areas, with extensive glaciers and exposed rock (Plate 6.2-1). Vegetation may be lush and diverse near the transition from parkland zones, and quickly becomes sparse as the elevation increases. Vegetation consists of mountain heathers (*Cassiope* spp.); 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).



Red Mountain Underground Gold Project

Predictive Ecosystem Mapping

Figure 6.2-1

Date: 6/1/2017
Map Number: RM-023
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

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Legend

- Community
- Red Mountain
- Highway
- Regional Study Area

General Ecosystem Type

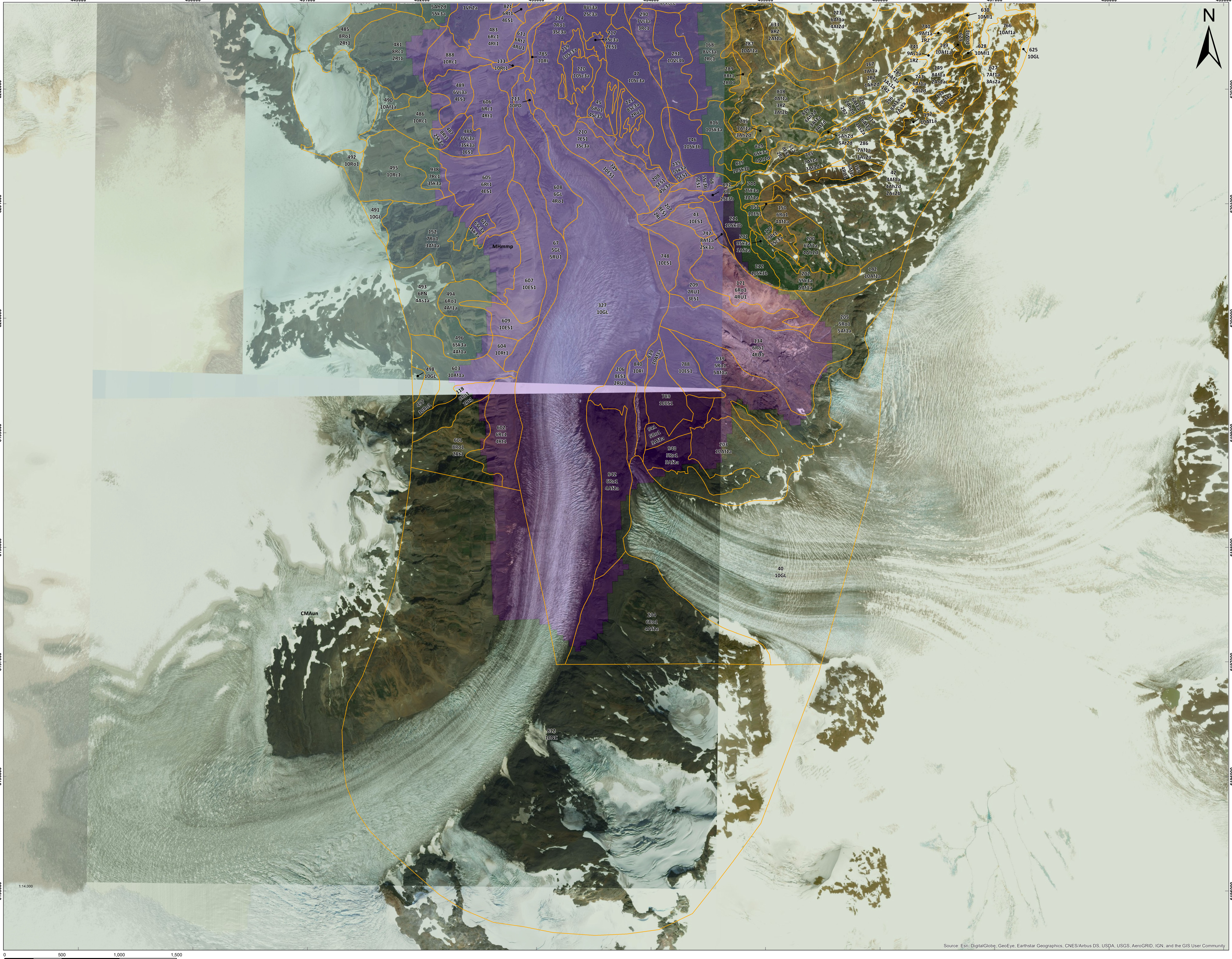
- Permanent Snow and/or Glacier
- Alpine
- Parkland
- Sparsely Vegetated
- Forested
- Floodplain
- Anthropogenic
- Listed
- Wetland
- Water

Red Mountain Underground Gold Project

Terrestrial Ecosystem Mapping within the Local Study Area (Map 1 of 4)

Figure 6.2-2a

Map Number: RM-022a
Date: 6/2/2017
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983



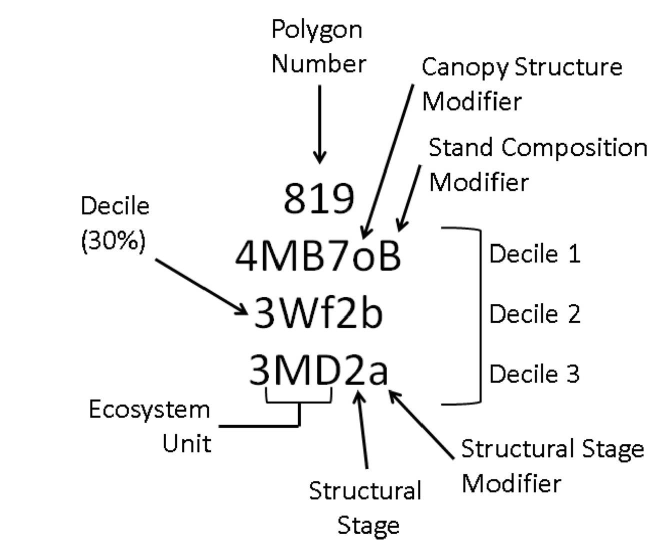
Legend

Terrestrial Ecosystem Mapping Polygons

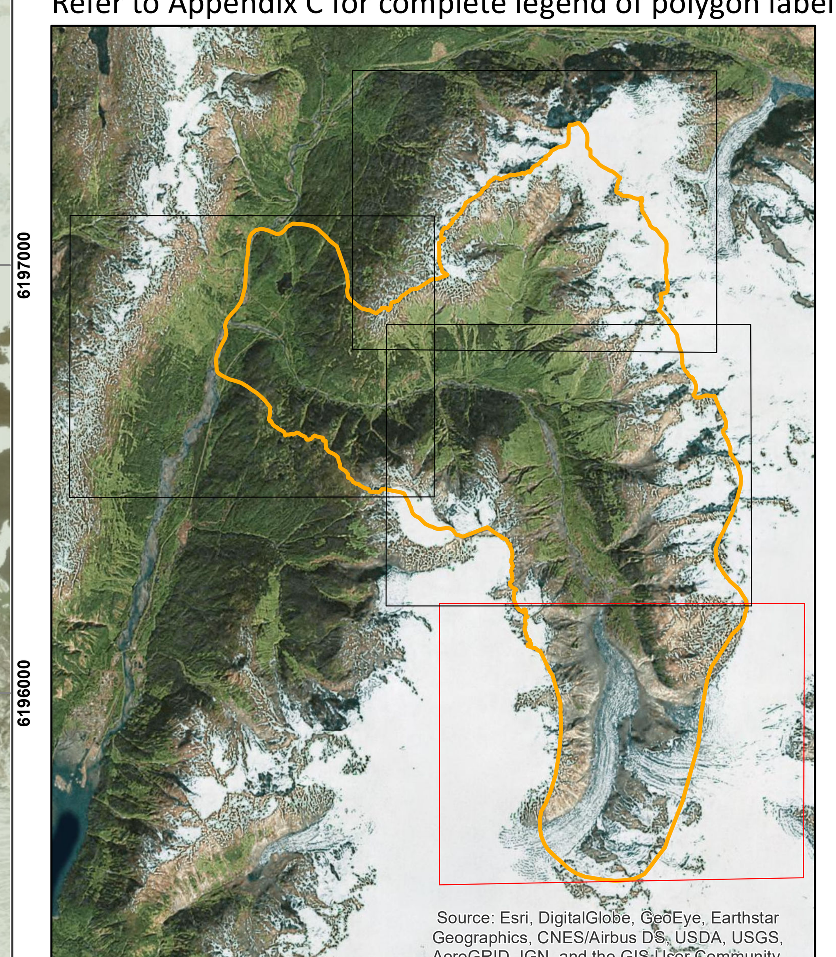
BEC Zone

- CMAun
- CWHwm
- MHmm1
- MHmmp

Terrestrial Ecosystem Mapping Polygon Key



Note:
Refer to Appendix C for complete legend of polygon labels



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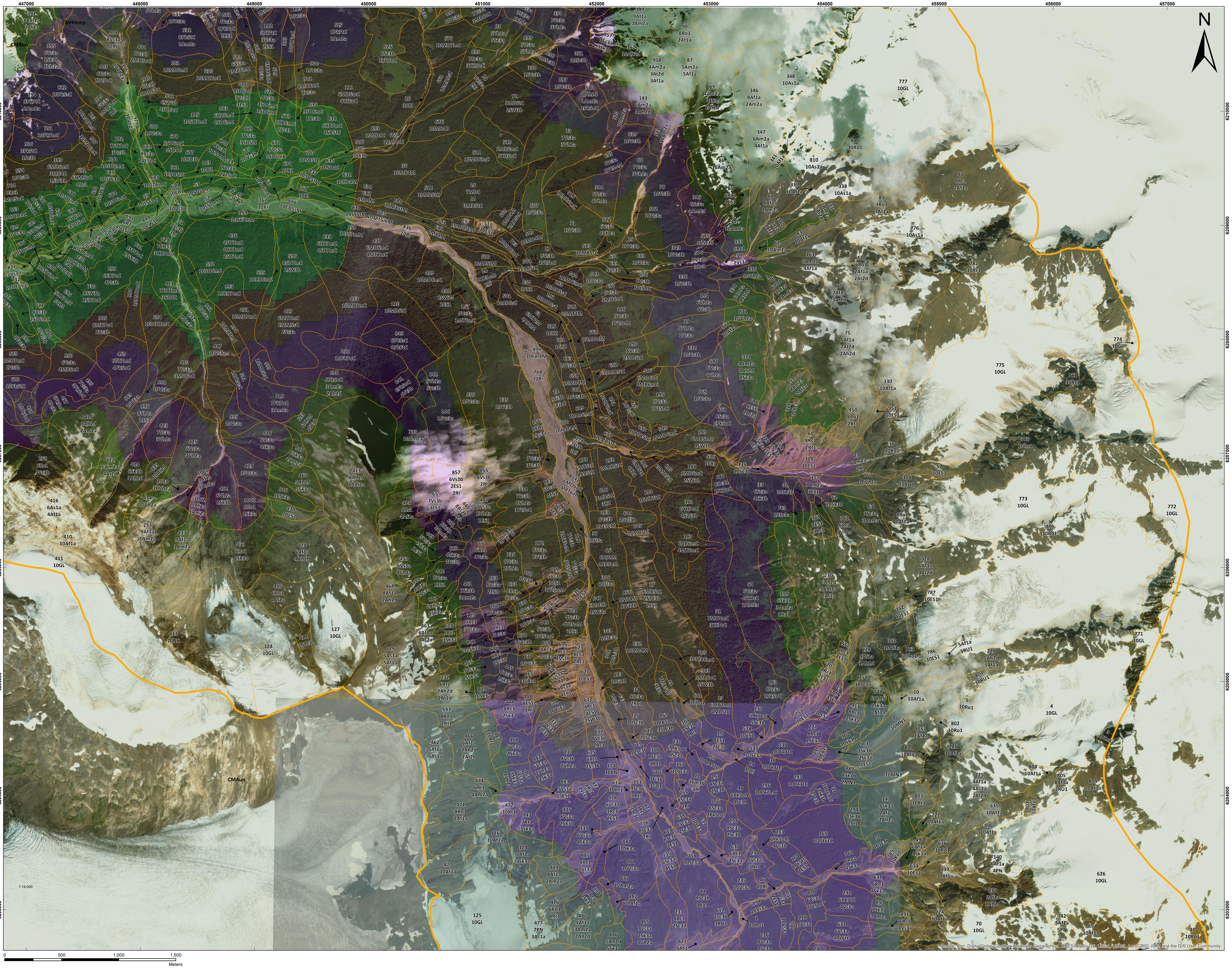


Red Mountain Underground Gold Project

Terrestrial Ecosystem Mapping within the Local Study Area (Map 2 of 4)

Figure 6.2-2b

Map Number: RM-022b
Date: 6/2/2017
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

Legend

Terrestrial Ecosystem Mapping Polygons

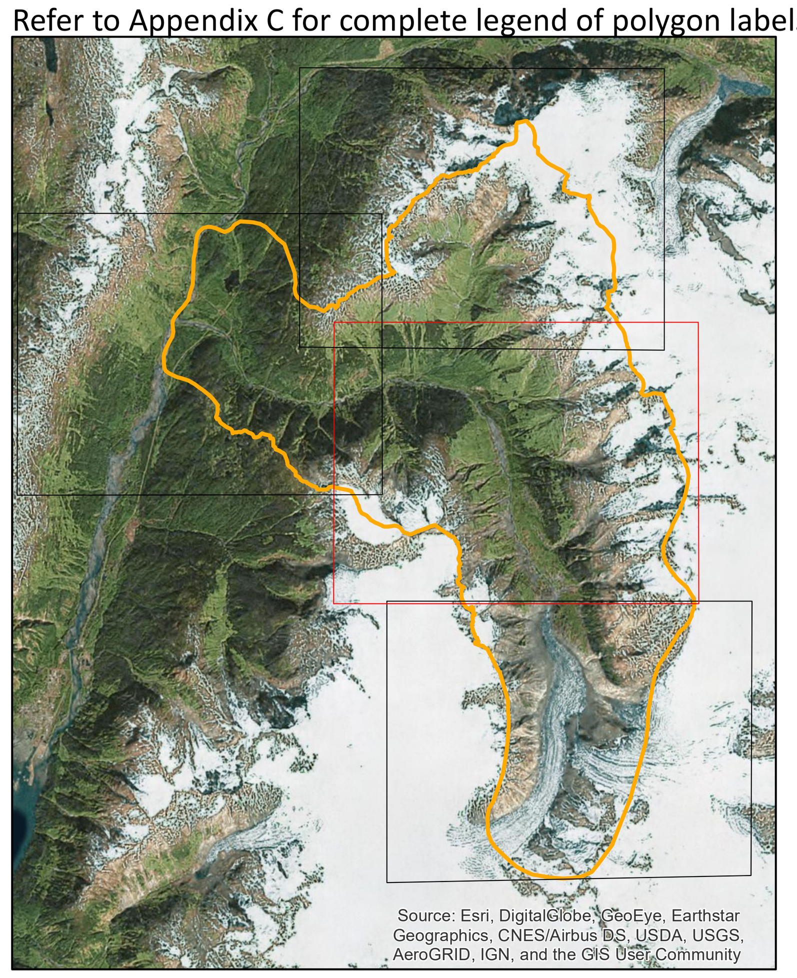
BEC Zone

- CMAun
- CWHwm
- MHmm1
- MHmmp

Terrestrial Ecosystem Mapping Polygon Key

Polygon Number
Canopy Structure Modifier
Stand Composition Modifier
Decile (30%)
819
4MB7oB
3Wf2b
3MD2a
Decile 1
Decile 2
Decile 3
Ecosystem Unit
Structural Stage
Structural Stage Modifier

Note:
Refer to Appendix C for complete legend of polygon labels



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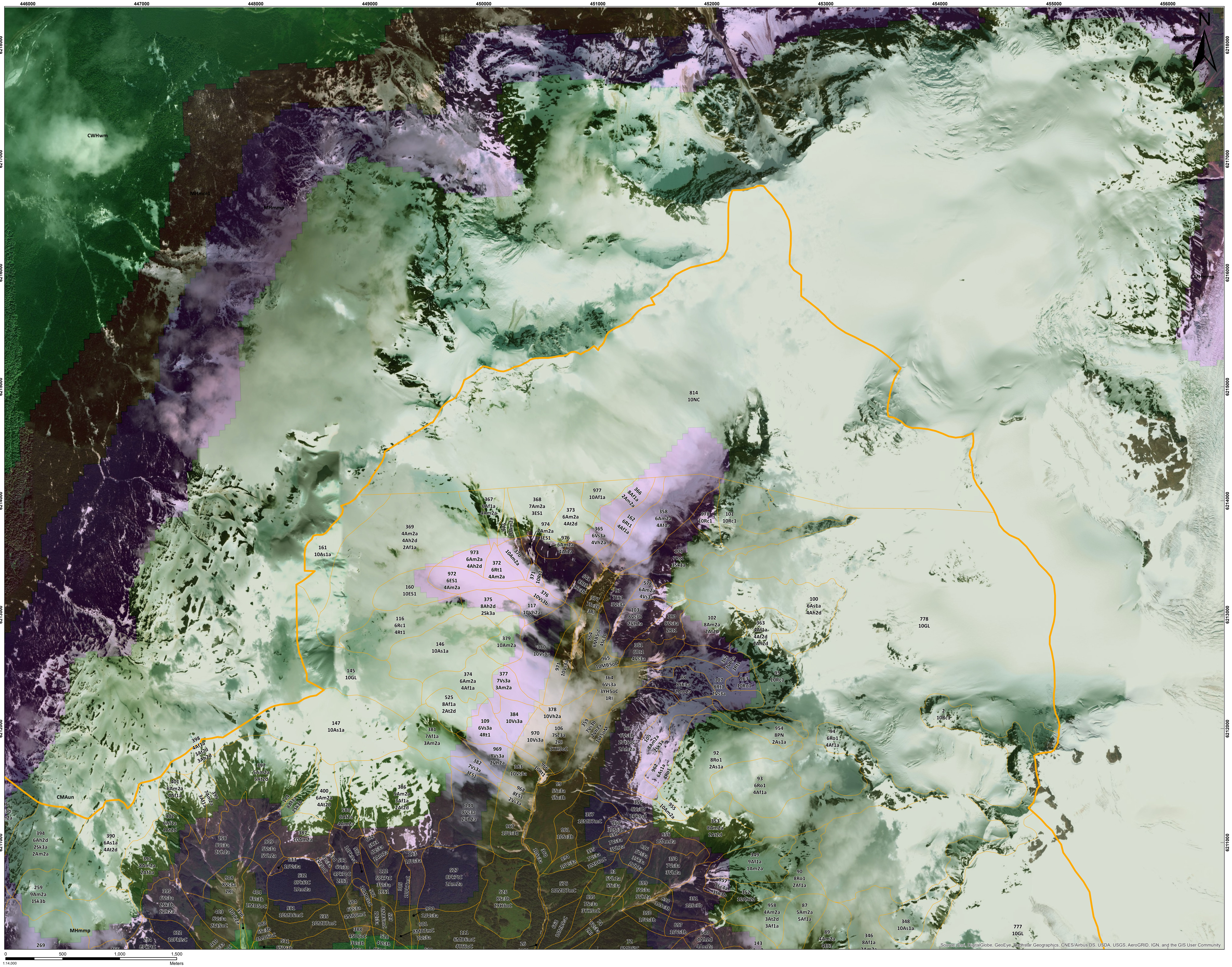


Red Mountain Underground Gold Project

Terrestrial Ecosystem Mapping within the Local Study Area (Map 3 of 4)

Figure 6.2-2c

Map Number: RM-022c
Date: 6/2/2017
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

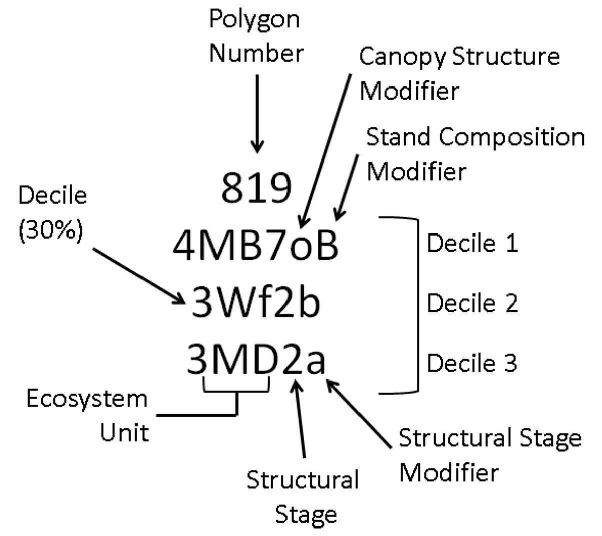
Legend

Terrestrial Ecosystem Mapping Polygons

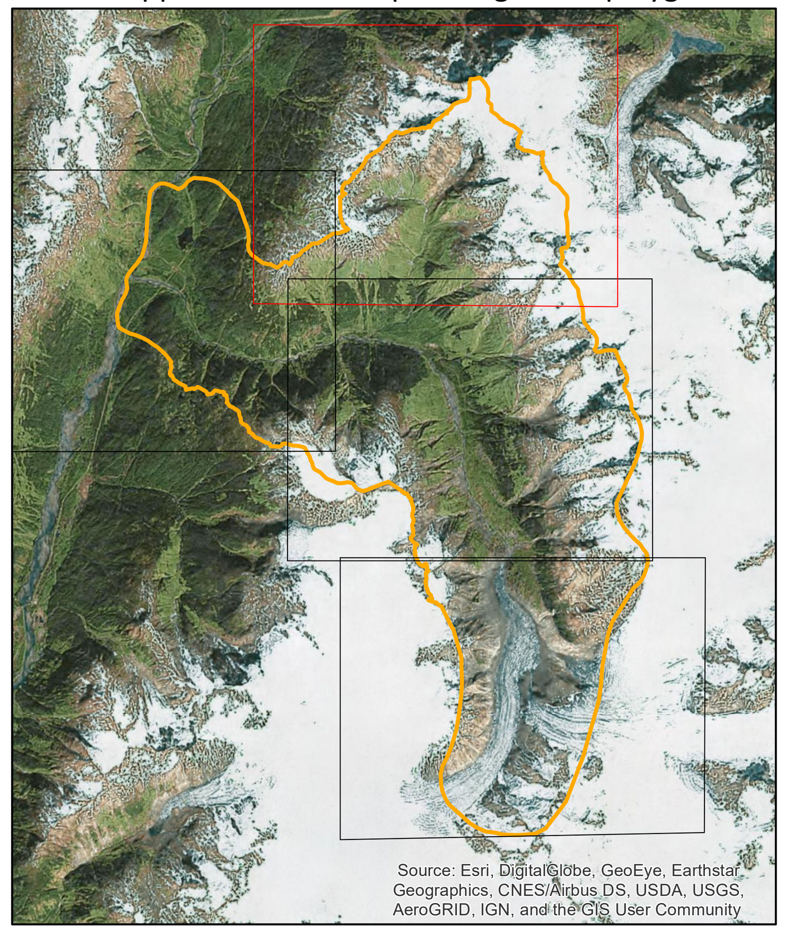
BEC Zone

- CMAun
- CWHwm
- MHmm1
- MHmmp

Terrestrial Ecosystem Mapping Polygon Key



Note:
Refer to Appendix C for complete legend of polygon labels



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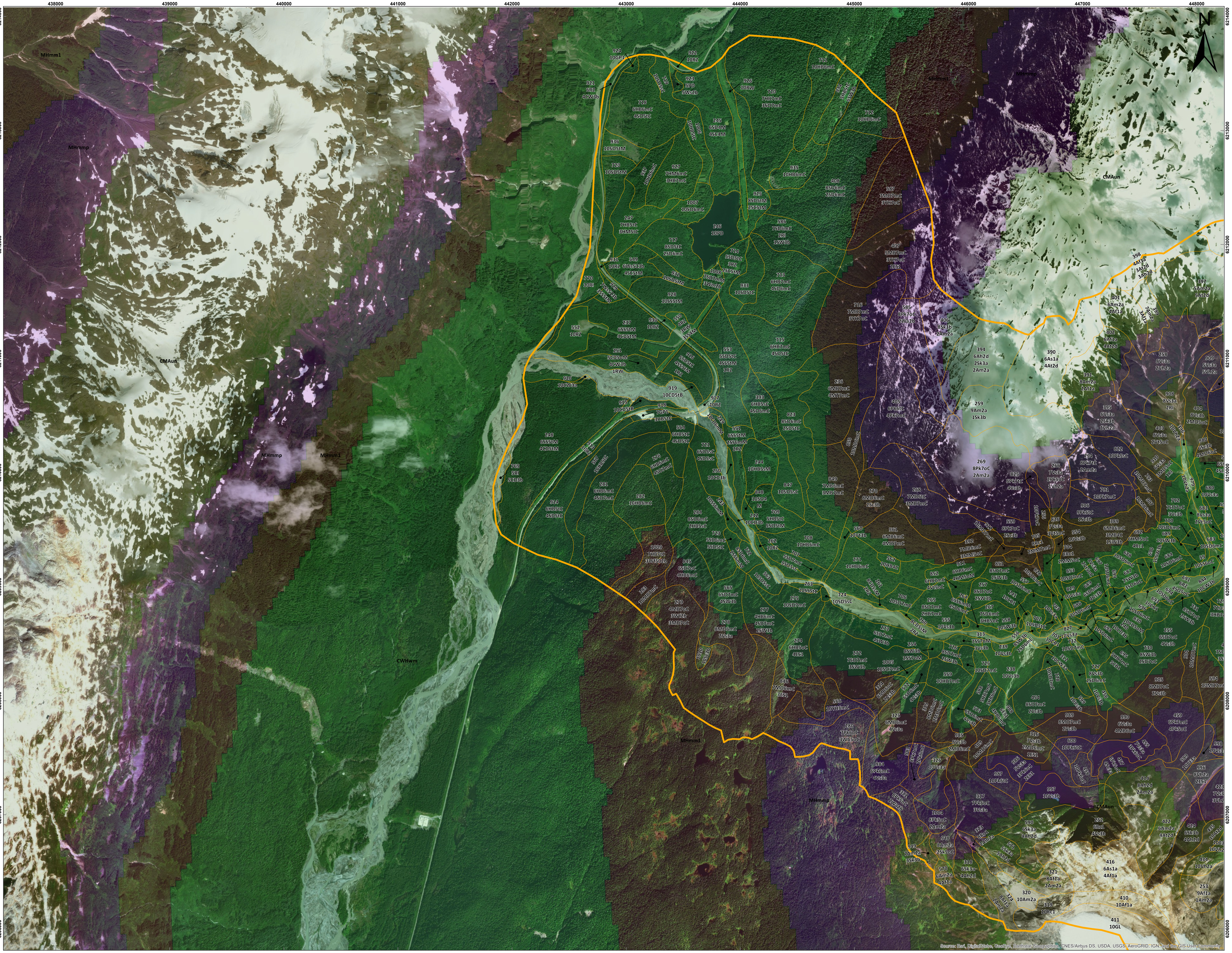


Red Mountain Underground Gold Project

Terrestrial Ecosystem Mapping within the Local Study Area (Map 4 of 4)

Figure 6.2-2d

Map Number: RM-022d
Date: 6/2/2017
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

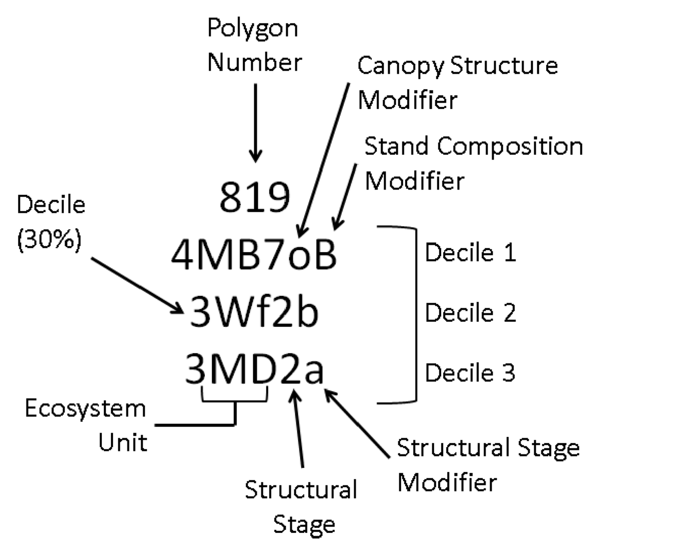
Legend

Terrestrial Ecosystem Mapping Polygons

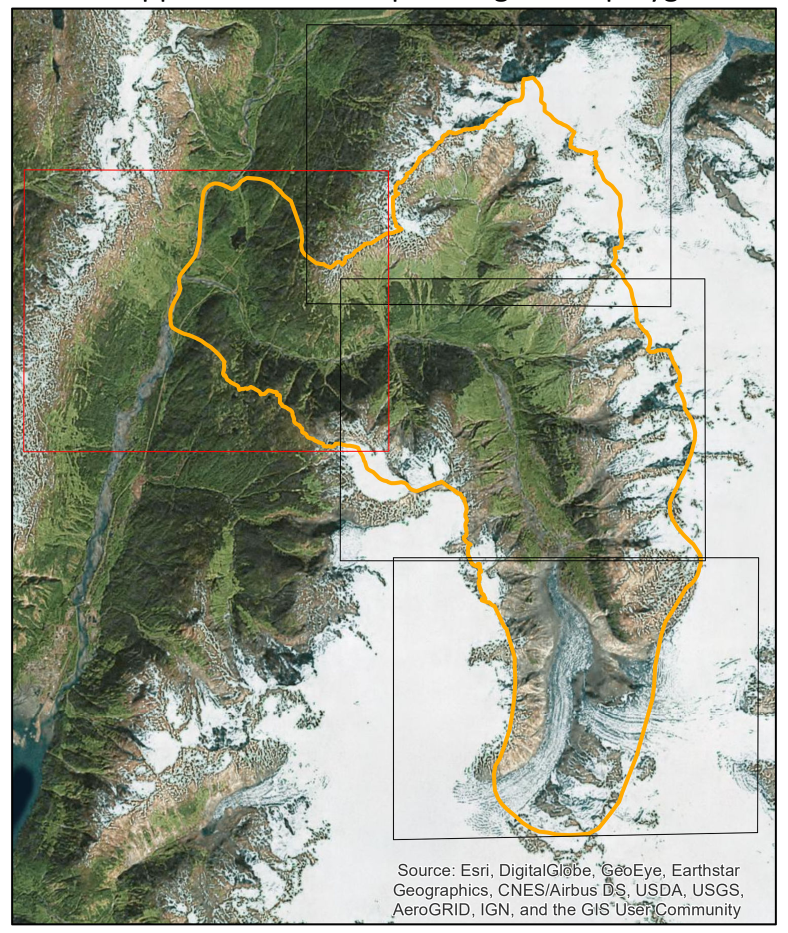
BEC Zone

- CMAun
- CWHwm
- MHmm1
- MHmmp

Terrestrial Ecosystem Mapping Polygon Key



Note:
Refer to Appendix C for complete legend of polygon labels



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Red Mountain

Table 6.2-1. BEC Units in the Regional Study Area, Local Study Area, and Project Footprint Study Area

BEC Unit Name	BEC Unit Label	RSA Extent (ha)	RSA Extent (%)	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
Coastal Mountain-heather Alpine - Undifferentiated Subzone	CMAun	106,165.7	50.2	8,222.9	51.8	165.7	17.2
Coastal Western Hemlock - Wet Maritime Subzone	CWHwm	17,695.6	8.4	1968.9	12.4	352.2	36.7
Interior Cedar Hemlock - Very Wet Cold Subzone	ICHvc	11,199.9	5.3	0.0	0.0	0.0	0.0
Mountain Hemlock - Moist Maritime Subzone - Windward Variant	MHmm1	10,849.2	5.1	2,264.5	14.3	240.0	25.0
Mountain Hemlock - Moist Maritime Subzone - Leeward Variant	MHmm2	23,317.0	11.0	0.0	0.0	0.0	0.0
Mountain Hemlock - Moist Maritime Parkland	MHmmp	42,342.0	20.0	3,403.6	21.5	202.9	21.1
Total		**211,569.6**	**100.0**	**15,859.9**	**100.0**	**960.7**	**100.0**

Plate 6.2-1. A typical portion of the CMAun showing converging glaciers in the valley bottom southeast of Treble Mountain, with sparsely vegetated slopes around and steep rocky mountain peaks above.

The CMAun covered just over 50% of the RSA (106,166 hectares) occupying the large high elevation area in the middle of the RSA (mainly covered by the Cambria Ice Fields), as well as numerous other smaller high elevation peaks and ridges. The PEM resulted in the modelling of ten vegetated and non-vegetated ecosystem types in the CMA (Table 6.2-2). Glaciers and a combination of glaciers and permanent snow occupied the largest portion of the CMA and is the largest mapped ecosystem (34.1%) in the RSA.

Table 6.2-2. Mapped CMAun Ecosystems in the RSA

Description	Map Code	Structural Stage	Total Area	Percent of RSA
Alpine Fellfield	Af	1	18,855.3	8.9
Alpine Heath	Ah	2d	1,516.7	0.7
Alpine Meadow	Am	2a	2,067.3	1.0
Alpine Tundra	At	2d	590.9	0.3
Krummholz	Sk	3	1,341.7	0.6
Glacier	GL		69,635.4	32.9
Permanent Snow and/or Glacier	PN | GL		2,508.4	1.2
Rock Outcrop (includes cliffs)	RO		9,166.1	4.3
Pond	PD		472.6	0.2
Alpine wetland	Wa	2b	11.2	0.0
Total			106,165.6	50.2

The CMAun covered 51.8% (8,223 hectares) of the LSA and 17.9% (164 hectares) of the PFSA (Table 6.2-3). A large portion (11.3%) of the CMAun in the LSA was not classified due to a lack of air photo coverage. The largest mapped unit in CMAun was glacier and permanent snow (13% of the LSA), including portions of the Cambria Icefield, Bromley Glacier and other small disjunct areas. Sparse and non-vegetated units made up another 8.4% of the LSA, including frequent rock outcrops, cliffs, and exposed soil mainly at higher elevations and exposed areas.

Vegetated ecosystem units of the LSA and PFSA included typical alpine ecosystems, along with multiple avalanche slopes. Alpine fellfield was the most commonly mapped unit (8.4% of the LSA and 6.2% of the PFSA) and consisted of sparsely vegetated poorly-developed morainal and colluvial soils and, less frequently, rock outcrops. These areas were generally high-elevation sites, where small sheltered areas or water-accumulating features have resulted in a sparse (less than 10%) cover of a variety of alpine herbs such as moss campion (*Silene acaulis*) and dwarf shrubs. Alpine heath was also relatively common in the LSA (2.4%) and PFSA (1.8%), mainly in slight depressions and sheltered locations. These communities contained a continuous cover of heathers (*Cassiope* spp. and *Phyllodoce* spp.) and occasionally partridge-foot (*Luetkea pectinata*), along with a sporadic occurrence of other species. Alpine heather often occurred in mosaics with other communities, including alpine tundra and krummholz (Plate 6.2-2). Krummholz ecosystems were mapped sporadically in the LSA (1.0%) and PFSA (0.7%). It typically occurred in the transitional areas where parkland forests of the MHmmp turned into alpine. Krummholz communities were dominated by old, stunted subalpine fir and, less often, mountain hemlock.

Table 6.2-3. Mapped CMAun Ecosystems in the Local and Project Footprint Study Areas

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
Alpine	00/Af	Alpine Fellfield	1a	1324.9	8.4	59.6	6.2
	00/Ah	Alpine Heath	2d	384.2	2.4	17.5	1.8
	00/Am	Alpine Meadow	2a	473.2	3.0	0.0	0.0
	00/As	Alpine Nivation (Late Snowbed)	1a	415.4	2.6	0.8	0.1
			2b	19.8	0.1	0.2	0.0
	00/At	Alpine Tundra	2d	203.7	1.3	21.6	2.2
	00/Sc	Shrub carr	3a	7.7	0.0	0.0	0.0
	00/Sk	Krummholz	3a	121.0	0.8	5.0	0.5
			3b	26.0	0.2	2.4	0.2
	00/Vh	Avalanche Herb Meadow	2a	16.3	0.1	0.0	0.0
	00/Vs	Avalanche Shrub Thicket	3a	37.1	0.2	0.0	0.0
			3b	7.9	0.0	0.0	0.0
Anthropogenic	00/MI	Mine	1	3.0	0.0	3.5	0.4
	00/RZ	Road		23.1	0.1	9.9	1.0
Not Classified	00/NC	Not Classified (no air photo coverage)		1793.5	11.3	0.0	0.0
Permanent Snow and/or Glacier	00/GL	Glacier		2018.6	12.7	6.9	0.7
	00/PN	Permanent Snow		44.0	0.3	3.9	0.4
Sparsely Vegetated	00/ES	Exposed Soil	1	86.8	0.5	5.8	0.6
	00/MN	Moraine	1	25.0	0.2	0.0	0.0
	00/Rc	Cliff	1	565.6	3.6	2.5	0.3
	00/Ro	Rock Outcrop	1	516.5	3.3	20.7	2.2
	00/Rt	Talus	1	84.0	0.5	3.3	0.3
	00/RU	Rubble	1	24.1	0.2	0.4	0.0
				0.0	0.0	0.3	0.0
Water	00/RI	River		1.2	0.0	1.4	0.1
Wetland	00/Wa	Alpine wetland	2b	0.0	0.0	0.1	0.0
		Total		**8222.9**	**51.8**	**165.7**	**17.2**

Plate 6.2-2. Typical CMAun upper slope, sheltered area with alpine heath in the foreground and a mix of krummholz and alpine meadow in the background.

Alpine meadows were common in the LSA (3.0%) but not mapped within the PFSA. These meadows occurred on steep, rich colluvial slopes and contained a diverse assemblage of herbs and graminoids (Plate 6.2-3). Typical species with a high cover included Sitka valerian (*Valeriana sitchensis*), cow parsnip (*Heracleum maximum*) and arrow-leaved groundsel (*Senecio triangularis*). Alpine tundra was uncommon in the LSA (1.3%) and slightly more common in the PFSA (2.2%). These communities typically occurred on the crests of small and large rocky ridges in exposed locations (Plate 6.2-4). Species were variable, with dwarf shrubs and graminoids common, along with a high cover of lichens. Alpine nivation was relatively common in the LSA (2.7%) and rarely mapped in the PFSA (0.1%). These communities develop in depressions and other locations where the snowpack persists for extended periods resulting in wet conditions for a large portion of the growing season (Plate 6.2-4). Typical species are varied, with both sparse herbaceous communities and graminoid-dominated communities common.

Avalanche slopes were uncommon in the LSA (0.4%) and not mapped in the PFSA. Mapped avalanche slopes were limited to the start of the slope and included herb meadow and shrub that were connected to larger avalanche tracks below.

Plate 6.2-3. Alpine tundra in the foreground on a CMAun ridge above Roosevelt Creek, with sparsely vegetated fellfields on the background ridge and lush alpine meadow below.

Plate 6.2-4. Alpine nivation community in the foreground with small stream. The background shows a mix of alpine fellfield and active colluvial slopes (talus), with rock outcrops above.

6.2.2 Coastal Western Hemlock - Wet Maritime Subzone

The CWHwm is the most northerly of the CWH subzones, occurring from Stewart to the Nass River, and north along the inside of the Alaska Panhandle. It occurs from sea level to about 600 masl, and is characterized by heavy snowfall, steep terrain, and relatively low plant diversity compared to southern CWH subzones. Western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*) are the dominant tree species, with infrequent occurrences of western red cedar (*Thuja plicata*), yellow cedar (*Chamaecyparis nootkatensis*) and amabalis fir (*Abies amabilis*). Oval-leaved blueberry (*Vaccinium ovalifolium*) and Alaskan blueberry (*Vaccinium alaskaense*), are abundant in the understory, as are herbaceious species such as bunchberry (*Cornus canadensis*), five-leaved bramble (*Rubus pedatus*), and spiny wood fern (*Dryopteris expansa;* (Banner et al., 1993).

The CWHwm mainly occurs along the Bear River valley, and include numerous smaller drainages such as Bitter Creek and Marmot River. It also occurs along valley bottoms in the south end of the RSA, notably along the Sutton and Kshwan Rivers. It accounted for 8.4% of the RSA (17,696 hectares) with 10 forested ecosystems mapped. Of those, all but the zonal site series comprised less than 1% of the RSA. Floodplain ecosystems were frequently mapped in the CWHwm, particularly along the Bear River where they were mixed with a variety of swamps and marshes (Plate 6.2-5). The steep, rugged terrain present in much of the mapped CWHwm is indicated by the high percent of avalanche ecosystems that is otherwise uncommon in lower elevations.

Plate 6.2-5. Looking down the Bear River valley where it drains into Portland Canal at the town of Stewart. Note the mosaic of CWHwm floodplain forest and wetlands along the valley bottom and the abrupt transition to steep mountain slopes.

The most common ecosystem unit modelled in the CWHwm was the zonal 01 - HwSs – Blueberry (2.4%) (Table 6.2-4). As discussed in the data limitation, this result may be partially due to the soil and moisture modelling resulting in more mesic/medium sites than expected. Avalanche units accounted for a total of 1.6% of the RSA (including those mixed with willow – alder shrubland). The only other units that accounted for more than 1% of the RSA was both pure and mixed 03 - SsHw - Oak fern and/or 04 - SsHw - Devil's club (1.8%).

Table 6.2-4. Mapped CWHwm Ecosystems in the RSA

Description	Map Code	Total Area	Percent of RSA
01 - HwSs - Blueberry	HB	5,157.8	2.4
02 - HwSs - Step moss	HM	1,185.8	0.6
03 - SsHw - Oak fern	SO	812.2	0.4
03 - SsHw - Oak fern and/or 04 - SsHw - Devil's club	SO | SD	1,290.3	0.6
04 - SsHw - Devil's club	SD	1,588.8	0.8
05 - Ss - Salmonberry - high bench floodplain	SS	464.4	0.2
06 - Act - Red-osier dogwood - mid bench floodplain	CD	165.6	0.1
08 - Hw - Sphagnum	HS	187.5	0.1
09 - Ss - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	SC	168.7	0.1
10 - Pl - Sphagnum - bog wetland	LS	116.5	0.1
Avalanche Herb Meadow	Vh	1,105.1	0.5
Avalanche Shrub Thicket	Vs	197.4	0.1
Avalanche Shrub Thicket | Shrubland (willow/alder thicket)	Vs | SW	2,105.2	1.0
Bog Wetland	Wb	163.5	0.1
Exposed Soil	ES	195.9	0.1
Herb Wetland (marsh and/or fen)	Wh	262.7	0.1
Low bench floodplain | Gravel Bar	Fl | GB	132.2	0.1
River	RI	1125	0.5
Road	RZ	123.1	0.1
Rock Outcrop (includes cliffs)	RO	111.9	0.1
Shrub Wetland (swamp and/or fen)	WE	333.4	0.2
Shrubland (willow/alder thicket)	SW	20.1	0.0
Swamp Wetland	Ws	441.3	0.2
Urban Residential	UR	212.1	0.1
Water (includes ponds and ocean)	Water	29.2	0.0
Total		**17,695.7**	**8.4**

The CWHwm covered 12.4% (1,969 hectares) of the LSA and 36.8% (335 hectares) of the PFSA (Table 6.2-5). The CWNwm included six forested ecosystem units, including three at-risk ecosystems, along with shrub floodplains, multiple wetlands, and a variety of avalanche and sparsely vegetated communities. Forested ecosystems occurred in a consistent pattern in the Bitter Creek watershed, with zonal sites (01 - HwSs – Blueberry) occurring on mid-slope positions on colluvial and morainal material and well drained glaciofluvial terraces (Plate 6.2-6). They covered 3.1% of the LSA and 6.6% of the PFSA. Wetter portions of these slopes were intermixed with the richer 03 - SsHw - Oak fern ecosystem type, often along streams and gullies. Lower slope and toe positions frequently contained 03 - SsHw - Oak fern (covering 2.9% of the LSA and 5.5% of the PFSA) or the wet and rich 04 - SsHw - Devil's club community (covering 1.9% of the LSA and 4.7% of the PFSA). Forest stands occurring on the toe and lower slopes typically consisted of large, well-spaced productive forests. A large portion of the lower and toe communities, and the majority of the forested units occurring on glaciofluvial terraces were mapped as pole-sapling to young second growth stands that were previously logged. On the upper slopes of the CWHwm, the dry, poor 02 - HwSs - Step moss forest type (a blue-listed ecosystem) was occasionally mapped in the LSA (0.2%) and absent from the PFSA. These dry, poor stands are uncommon in the area in general, as the high year round precipitation rates are not conducive to their development.

Plate 6.2-6. Old growth CWHwm 01/HB stand on a lower slope morainal terrace above Bitter Creek.

Avalanche slopes were frequently mapped in the CWHwm (0.7% of the LSA and 2.4% of the PFSA), but were typically restricted in narrow tracks often along creek draws. These ecosystems ranged from alder and willow dominated thickets, to rich herb meadows on mid and upper slopes. Occasional treed avalanche slopes were mapped along the edges of the tracks as narrow, linear features where frequent slides have resulted in heavily damaged or stunted stands.

Table 6.2-5. Mapped CWHwm Ecosystems in the Local and Project Footprint Study Areas

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Exten t (%)	PFSA Extent (ha)	PFSA Extent (%)
Anthropogenic	00/GP	Gravel Pit	1	2.8	0.0	0.0	0.0
	00/RW	Rural		13.6	0.1	0.0	0.0
	00/RZ	Road		67.8	0.4	16.3	1.7
Floodplain	00/Fl	Low bench floodplain	3a	0.0	0.0	0.7	0.1
			3b	0.0	0.0	0.0	0.0
	05/SS	05 - Ss - Salmonberry - high bench floodplain	3b	1.1	0.0	0.3	0.0
			4	3.7	0.0	5.2	0.5
			5	107.1	0.7	23.5	2.4
			6	8.2	0.1	5.1	0.5
			7	12.6	0.1	10.4	1.1
	06/CD	06 - Act - Red-osier dogwood - mid bench floodplain	3a	2.1	0.0	0.0	0.0
			3b	6.3	0.0	3.0	0.3
			4	0.0	0.0	11.2	1.2
			5	55.0	0.3	5.0	0.5
			6	1.0	0.0	2.4	0.2
			7	0.0	0.0	1.2	0.1
	07/CW	07 - Act - Willow	3a	1.3	0.0	0.0	0.0
			3b	9.6	0.1	0.0	0.0
Forested	00/Sc	Shrubland	3a	0.0	0.0	1.9	0.2
	00/SW	Shrubland (willow/alder thicket)	3a	0.0	0.0	0.4	0.0
			3b	69.0	0.4	9.2	1.0
	00/Vh	Avalanche Herb Meadow	2a	1.6	0.0	0.4	0.0
	00/Vs	Avalanche Shrub Thicket	3a	33.2	0.2	5.2	0.5
			3b	85.5	0.5	17.3	1.8
	00/Vt	Avalanche Treed	3b	2.4	0.0	0.0	0.0
			5	3.7	0.0	0.0	0.0
	01/HB	01 - HwSs - Blueberry	3b	0.0	0.0	1.6	0.2
			4	10.7	0.1	38.8	4.0
			5	107.9	0.7	8.3	0.9
			6	201.7	1.3	15.8	1.6
			7	161.8	1.0	3.7	0.4

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Exten t (%)	PFSA Extent (ha)	PFSA Extent (%)
	02/HM	02 - HwSs - Step moss	5	18.1	0.1	0.0	0.0
			6	13.6	0.1	0.0	0.0
	03/SO	03 - SsHw - Oak fern	4	8.3	0.1	10.1	1.0
			5	80.1	0.5	15.5	1.6
			6	141.4	0.9	7.3	0.8
			7	228.5	1.4	21.6	2.2
	04/SD	04 - SsHw - Devil's club	3b	7.0	0.0	0.0	0.0
			4	19.9	0.1	0.4	0.0
			5	126.3	0.8	10.7	1.1
			6	74.1	0.5	17.7	1.8
			7	78.0	0.5	17.3	1.8
	09/Sc	09 - Ss - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	3a	0.0	0.0	0.4	0.0
Sparsely Vegetated	00/CB	Cutbank	1	4.9	0.0	3.4	0.4
	00/ES	Exposed Soil	1	11.5	0.1	3.4	0.4
	00/Rc	Cliff	1	6.7	0.0	0.3	0.0
Water	00/PD	Pond		20.3	0.1	0.0	0.0
	00/RI	River		123.2	0.8	57.1	5.9
Wetland	00/Wf	Fen Wetland	2b	0.0	0.0	0.2	0.0
	00/Wm	Marsh wetland	2b	1.1	0.0	0.0	0.0
	00/Ws	Swamp Wetland	2b	0.7	0.0	0.0	0.0
	09/SC	09 - Ss - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	4	12.4	0.1	0.0	0.0
			5	9.5	0.1	0.0	0.0
	Wf50/Wf50	Narrow-leaved cotton-grass - Peat-moss	2b	4.5	0.0	0.0	0.0
	Ws51/Ws51	Sitka Willow - Pacific Willow - Skunk Cabbage	3b	9.1	0.1	0.0	0.0
		Total		**1968.9**	**12.4**	**352.2**	**36.7**

Four types of floodplain ecosystems were mapped in the LSA, including two blue-listed communities. The 05 - Ss - Salmonberry - high bench floodplain (blue-listed) was the most common, occurring in 0.9% of the LSA and 4.6% of the PFSA, and including a large portion of mature and old forest (Plate 6.2-7). This ecosystem unit occurs on old fluvial plains that are infrequently flooded, but have seasonally high water tables. The 05 - Ss - Salmonberry - high bench floodplain ecosystem was mapped in large areas along Highway 37A where Bitter Creek joins Bear River, and on the narrow fluvial plains along the lower end of

Bitter Creek. Salmonberry (*Rubus spectabilis*), devil's club, blueberry (*Vaccinium* spp.) alder (*Alnus* spp.) and willow (*Salix* spp.) often formed a thick understory, while herbaceous species were variable. They typically contained a mix forest stand with well-spaced Sitka spruce and black cottonwood the dominant tree species. Active floodplains contained the 06 - Act - Red-osier dogwood - mid bench floodplain ecosystem (blue-listed). These communities occur at a lower elevation than the high-bench floodplains, and experience prolonged high groundwater tables and more frequent flood events (Plate 6.2-8). The high soil moisture limited conifer establishment resulting in a forested stand that is typically dominated by deciduous species, namely cottonwood and red alder (*Alnus rubra*) with a thick, contentious understory of salmonberry, red-osier dogwood (*Cornus stolonifera*), willow, and to a lesser extent devil's club. Herbaceous cover was variable, and moss cover sparse to absent.

Low bench floodplains occur directly adjacent to active rivers and creeks, as well as old river channels (Plate 6.2-9). They experience prolonged flooding, and when located along high gradient rivers such as Bitter Creek, are heavily scoured each year. Two types of low-bend floodplain were infrequently mapped, with 07 - Act – Willow (0.1% of the LSA and absent from the PFSA) found along lower portions of Bitter Creek, and unclassified low-bench floodplain (0.1% of the PFSA and absent from the LSA) occurring along smaller creeks that drain into Bitter Creek, and along upper portions of Bitter Creek. The 07 - Act – Willow is a highly variable community that contained a thick to sparse cover of shrubby cottonwood and willow growing on exposed sand and gravel. The unclassified units were variable communities that were directly associated with creeks, but due to their early serval stage and general site characteristics they could not be classified to a site series level. Over time it is expected they will develop into recognizable ecosystem types.

Plate 6.2-7. Old growth high-bench floodplain forest (CWHwm 05/SS) along Bitter Creek.

Plate 6.2-8. Typical Bitter Creek mid-bench floodplain forest (CWHwm 06/CD). The old overgrown road is visible along the right side of the photo.

Plate 6.2-9. Small creek draining into Bitter Creek, with low bench floodplains in the foreground. Note the old overgrown road in the middle of the photo as it passes over the creek below failing glaciofluvial deposits.

Wetlands were infrequent in the CWHwm, and included marshes, swamps and fens. Three swamps were mapped in the LSA (absent from the PFSA) including two named ecosystems and one generic unit. Ws54 - CwHw - Skunk cabbage swamps (0.2%), while uncommon in the LSA, are widespread in the CWHwm occurring in depressions on inactive floodplains, and seepage sites at the toe of slopes. Ws51 Sitka Willow - Pacific Willow - Skunk Cabbage was mapped in two locations between Clements Lake and Bear River. The Ws51 is an uncommon ecosystem found at low elevations in floodplain depressions, typically with rich Gleysol or organic soils (MacKenzie & Moran, 2004).

A Wf50 Narrow-leaved cotton-grass - Peat-moss fen was mapped in the LSA (<0.1%) on a ridge south of Bitter Creek at the transition to the MMmm1. Wf50 fens are more often found in subalpine areas of the Coastal Mountains. They are typically slopped wetlands that are dominated by a continuous cover of cottongrass (*Eriophorum* spp.) and peat-moss (*Sphagnum* spp.), along with a variable cover of typically wetland species or dwarf shrubs (Plate 6.2-10).

Plate 6.2-10. Pocket Wf50 fen on an upper elevation plateau at the transition from CWHwm to MHmm1.

Unclassified wetland types included swamps (less than 0.1% of the LSA), mainly in depressions on old floodplains, a single fen (0.2% of the PFSA) located adjacent the old road near the start of the Bitter Creek valley, and a modified marsh (less than 0.1% of the LSA) located on the south end of Clements Lake. These wetland ecosystems could not be identified past the federal wetland class due to past disturbance or a lack of characteristic features that fit them into the provincial classification system.

Sparsely vegetated communities covered the remainder of the ecosystems in the LSA (1%) and PFSA (7.1%), including rivers (creeks, streams and gravel bars), ponds, cliffs, river and road cut banks, cliffs and exposed soil. Much of the area mapped as exposed soil was un-vegetated moraines or eroding morainal material.

Disturbed areas included a large portion of the road (0.4 and 1.8%) along the north bank of Bitter Creek, a small portion of Highway 37A, and various gravel roads around the confluence with Bear River. Other disturbed features included an old gravel pit along Highway 37A, recently cleared areas near the confluence of Bear River, and the recreational sites at Clements Lake.

6.2.3 Interior Cedar Hemlock - Very Wet Cold Subzone

The ICH zone is a transitional zone, occurring from 240 to about 1,000 meters in elevation, between the wetter CWH zone to the west and the drier Sub-Boreal Spruce (SBS) zone to the east. It is characterized by a deep persistent snowpack and cool, moist summers. Zonal ecosystems are, like much of the ICHvc subzone, dominated by devil's club (*Oplopanax horridus*). Dominant tree species include Roche spruce (*Picea glauca x sitchensis)* and subalpine fir, with western hemlock and mountain hemlock occurring on drier upland sites (Banner et al., 1993; Ketcheson et al., 1991).

The ICHvc comprises 5.3% of the RSA (11,200 hectares) and occurs along the lower elevations in the east side of the RSA. It was not included within the LSA or PSFA boundaries. The ICHvc is located near Meziadin Lake and Surprise Creek in the northeast, Willoughby Creek in the east, and along White River in the southeast. Six forested ecosystems were mapped in the ICHvc subzone, along with multiple wetland and floodplain communities (Table 6.2-6; Plate 6.2-11). Only the zonal ecosystem type comprised more than 1% of the RSA.

Plate 6.2-11. Looking up Strohn Creek near Meziadin Lake at old growth ICHvc floodplain forests, with steep mountain slopes and avalanche slopes in the background.

Table 6.2-6. Mapped ICHvc Ecosystems in the RSA

Description	Map Code	Total Area	Percent of RSA
01 - HwBl - Devil's club	HD	2,282.8	1.1
01 - HwBl - Devil's club and/or 02 - Hw - Step moss	HD | HM	77.4	0.0
02 - Hw - Step moss	HM	1,245.4	0.5
03 - Sx - Devil's club	SD	902.8	0.4
04 - Sx - Devil's club - Dogwood and/or 05 - ActSx - Dogwood - active floodplain	DD | CD	162.6	0.1
05 - ActSx - Dogwood - active floodplain	CD	57.9	0.0
06 - Sx - Horsetail (Ws07 - Sxw - Common horsetail - Leafy moss)	SH	1,099.2	0.5
Avalanche Herb Meadow	Vh	296.2	0.1
Avalanche Shrub Thicket | Shrubland (willow/alder thicket)	Vs | SW	1,950.0	0.9
Bog Wetland	Wb	46.6	0.0
Bog Wetland	Wb	292.0	0.1
Exposed Soil	ES	130.5	0.1
Herb Wetland (marsh and/or fen)	Wh	330.1	0.2
Pond	PD	35.9	0.0
River	RI	392.6	0.2
Road	RZ	39.8	0.0
Rock Outcrop (includes cliffs)	RO	44.8	0.0
Shrub Wetland (swamp and/or fen)	WE	384.4	0.2
Shrubland (willow/alder thicket)	SW	546.3	0.3
Swamp Wetland	Ws	882.8	0.4
Total		**11,199.9**	**5.3**

6.2.4 Mountain Hemlock - Moist Maritime Subzone - Windward Variant

The MHmm1 occurs on higher elevations on maritime areas of the coast and Vancouver Island. It occurs from about 800 to 1350 masl, although there is considerable range in both the lower and upper elevational limits. The MHmm1 has long winters that are wet and cold with a persistent snowpack, and short cool, moist summers. Snowfall is high and persistent. Forests are dominated by subalpine fir and mountain hemlock, typically with a thick understory of Alaskan blueberry, oval-leaved blueberry. Local topography strongly influences both forest characteristics and vegetation assemblages largely due to the variable persistence of snowpacks (Banner et al., 1993).

The MHmm1 covers 5.1% (10,849 hectares) of the RSA. It occurs on the west and south sides of the RSA where it typically forms a narrow elevational band above the CWHwm and below the MHmmp. Although mostly occurring on mid slopes of the steep mountain valley, it occasionally reaches valley bottom in higher elevation drainages. The PEM modelling resulted in the mapping of nine forested ecosystems, with only the zonal type exceeding 1% of the RSA (Table 6.2-7). As expected in the

MHmm1, avalanche ecosystems covered a large area (1.8% of the RSA). Small areas of wetlands also occurred, with the predominantly steep terrain precluding the development of large wetland communities, with the exception of frequent small perched bog communities on crests of rocky ridges (Plate 6.2-12).

Table 6.2-7. Mapped MHmm1 Ecosystems in the RSA

Description	Map Code	Total Area	Percent of RSA
01 - HmBa - Blueberry	MB	4,026.9	1.9
02 - HmBa - Mountain-heather	MM	658.5	0.3
03 - BaHm - Oak fern	MO	323.8	0.2
04 - HmBa - Bramble	AB	162.9	0.1
05 - BaHm - Twistedstalk	MT	309.0	0.1
06 - HmYc - Deer cabbage	MD	3.9	0.0
07 - YcHm - Hellebore	YH	46.1	0.0
08 - HmYc - Sphagnum	YS	80.2	0.0
09 - YcHm - Skunk cabbage	YC	102.2	0.0
Avalanche Herb Meadow	Vh	1,356.5	0.6
Avalanche Shrub Thicket | Shrubland (willow/alder thicket)	Vs | SW	2,551.8	1.2
Bog Wetland	Wb	65.3	0.0
Bog Wetland	Wb	16.2	0.0
Exposed Soil	ES	622.0	0.3
Glacier	GL	131.5	0.1
Herb Wetland (marsh and/or fen)	Wh	40.1	0.0
Pond	PD	17.8	0.0
River	RI	115.0	0.1
Rock Outcrop (includes cliffs)	RO	219.8	0.1
Total		**10,849.2**	**5.1**

MHmm1 comprised 14.3% (2,265 hectares) of the LSA and 23.2% (212 hectares). As with the RSA, zonal (01 - HmBa - Blueberry) forested ecosystems were the most common unit mapped, including a sizeable amount of mature and old growth forest (Table 6.2-8). These mesic forests typically occurred on steep mid slopes (often intermixed with richer 03 - BaHm - Oak fern units) on all aspects, as well as on lower slope glacofluvial terraces (Plate 6.2-13). Wet and wet-rich forested areas occurred primarily on the lower slopes and toes of the mountain, where continual groundwater results in nutrient rich soils. The 05 - BaHm – Twistedstalk ecosystem unit was commonly found in these water receiving sites, with productive well-spaced forest stands commonly observed. The wet, poor community type (04 - HmBa – Bramble) was frequently found on lower slopes where there was abundant groundwater, but parent material and a lack of soil development resulted in a poorer community type.

Plate 6.2-12. Looking downslope at MHmm1 showing CWHwm floodplains along Sutton River below and the transition to the MHmmp above. Note the light coloured forest on the rock hump in the middle of the photo where bog wetlands of stunted mountain hemlock.

The lack of soil development was particularly evident in the southern portion of the MHmm1 in the vicinity of the Bromley Humps, where vegetation communities were found to occur in an early seral stage. The valley bottom starting around Bromley Humps and continuing north is strongly influenced by the relatively recent retreat of Bromley Glacier resulting in the area being dominated by early seral communities. The early seral ecosystems were loosely fit into the BEC system and mapped as ecosystem units when possible (including a large portion of the mapped dry, poor 02 - HmBa - Mountain-heather ecosystem). When they did not fit into the BEC system, they were mapped as shrublands (with the SW representing a wetter variant and Sc considered a dryer unit).

Upper elevation portions of the MHmm1 in the LSA contained small amounts of wet forested ecosystems (06 - HmYc - Deer cabbage and 07 - YcHm – Hellebore), along with extensive avalanche tracks. Extensive sparsely vegetated ecosystems were mapped along the west side of Bitter Creek intermixed with frequent avalanche tracks.

Floodplains in the MHmm1 were infrequent and small in extent. As no formal ecosystem units have been developed for floodplains in the MHmm1, generic low and mid-bench units (0.5% of the PFSA) were mapped (Fl and Fm). They largely occurred along the active floodplain of Bitter Creek and small alluvial fans where unnamed creeks drain into Bitter Creek (Plate 6.2-14). While the LSA contained small amount (0.2%) of 08 - HmYc – Sphagnum swamps and unclassified fens, the PFSA only contained a single unclassified fen (0.1%).

Table 6.2-8. Mapped MHmm1 Ecosystems in the Local and Project Footprint Study Areas

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
Anthropogenic	00/RZ	Road		11.5	0.1	11.2	1.2
Floodplain	00/Fl	Low bench floodplain	2d	3.6	0.0	0.3	0.0
			3a	2.3	0.0	1.2	0.1
			3b	7.0	0.0	0.0	0.0
	00/Fm	Middle bench floodplain	3b	0.0	0.0	3.4	0.4
			4	1.7	0.0	0.0	0.0
Forested	00/Sc	Shrubland (dry)	3a	51.8	0.3	0.3	0.0
			3b	68.4	0.4	0.3	0.0
	00/SW	Shrubland (willow/alder thicket)	3a	8.3	0.1	0.0	0.0
			3b	33.1	0.2	3.7	0.4
	00/Vh	Avalanche Herb Meadow	2a	31.7	0.2	0.0	0.0
	00/Vs	Avalanche Shrub Thicket	3a	301.4	1.9	0.9	0.1
			3b	184.5	1.2	5.8	0.6
	00/Vt	Avalanche Treed	3b	51.5	0.3	0.0	0.0
			5	22.0	0.1	0.0	0.0
	01/MB	01 - HmBa - Blueberry	3a	0.0	0.0	3.7	0.4
			3b	7.4	0.0	14.4	1.5
			4	80.1	0.5	2.7	0.3
			5	118.3	0.7	57.6	6.0
			6	243.3	1.5	5.4	0.6
			7	280.7	1.8	0.0	0.0
	02/MM	02 - HmBa - Mountain-heather	3a	0.0	0.0	0.9	0.1
			3b	0.0	0.0	3.6	0.4
			5	10.7	0.1	1.6	0.2
			7	0.6	0.0	0.0	0.0
	03/MO	03 - BaHm - Oak fern	3a	0.0	0.0	0.7	0.1
			3b	5.0	0.0	9.3	1.0
			4	21.4	0.1	1.6	0.2
			5	41.0	0.3	13.9	1.4

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
			6	129.1	0.8	19.2	2.0
			7	67.0	0.4	2.5	0.3
	04/AB	04 - HmBa - Bramble	3b	0.0	0.0	4.7	0.5
			4	23.6	0.1	2.9	0.3
			5	24.6	0.2	23.2	2.4
			6	11.6	0.1	0.0	0.0
	05/MT	05 - BaHm - Twistedstalk	3b	0.0	0.0	1.6	0.2
			4	20.3	0.1	0.0	0.0
			5	33.7	0.2	9.1	0.9
			6	14.4	0.1	14.6	1.5
			7	27.8	0.2	0.0	0.0
	06/MD	06 - HmYc - Deer cabbage	7	22.6	0.1	0.0	0.0
	07/YH	07 - YcHm - Hellebore	5	11.8	0.1	0.0	0.0
			6	23.8	0.2	0.0	0.0
			7	39.5	0.2	0.0	0.0
Sparsely Vegetated	00/BI	Blockfield	1	1.1	0.0	0.0	0.0
	00/CB	Cutbank	1	6.2	0.0	0.0	0.0
	00/ES	Exposed Soil	1	64.9	0.4	9.3	1.0
	00/GB	Gravel Bar	1	0.4	0.0	0.0	0.0
	00/Rc	Cliff	1	12.3	0.1	0.5	0.1
	00/Ro	Rock Outcrop	1	3.9	0.0	3.1	0.3
	00/Rt	Talus	1	4.8	0.0	1.2	0.1
Water	00/PD	Pond		0.0	0.0	0.0	0.0
	00/RI	River		74.0	0.5	5.0	0.5
Wetland	00/Wf	Fen Wetland	2b	23.0	0.1	0.6	0.1
	08/YS	08 - HmYc - Sphagnum	6	19.4	0.1	0.0	0.0
			7	17.9	0.1	0.0	0.0
Total				**2264.5**	**14.3**	**240.0**	**25.0**

Plate 6.2-13. Mature MHmm1 01/MB forest along midslopes of the Bitter Creek Valley. These stands are widespread in the LSA, often intermixed with 03/MO ecosytems in water-receiving locations.

Plate 6.2-14. MHmm1 forests on mid slopes above Bitter Creek bisected by shrubby avalanche tracks along a small creek. The foreground shows regenerating CWHwm forests along the old overgrown road.

6.2.5 Mountain Hemlock - Moist Maritime Subzone - Leeward Variant

The MHmm2 occurs in submaritime areas of the mainland coast at elevations ranging from 900 to 1400 masl. As with the MHmm1, there is a considerable range in the upper and lower elevation limits. It is considered to be a transitional subzone that occurs between the coast and interior, with long, moist cold winters and short cool, moist summers. It is generally drier than the coastal MHmm1, but also contains persistent snowpacks (Banner et al., 1993)

The MHmm2 occurs on all of the eastern slopes of the RSA above the ICHvc and below the MHmmp, and is not present within the LSA or PSFA. As the eastern mountain slopes are generally more subdued than the western slopes, the MHmm2 occupies a wider range of upper to lower slopes, along with many valley bottoms. The MHmmp also occupies a narrower range on the eastern slopes, where it is largely limited to upper slopes and lower ridges, and generally lacking the extensive old growth stands observed in the Bitter Creek watershed. Nine forested ecosystems were modelled in the PEM, with the zonal site series covering 3.5% of the RSA (Table 6.2-9). Avalanche slopes were common and extensive and covered almost 3% of the RSA. Of particular note were the extensive wetlands that occur along Nelson Creek (eventually draining into White River) that span the valley bottom in the MHmm2 and ICHvc (Plate 6.2-15). It was the single largest wetland (roughly four km long) complex mapped in the RSA, and included multiple types of fen, swamp, and shrub-carrs, along with shrub and forested floodplains.

Plate 6.2-15. Looking downstream at a portion of the extensive wetland complex spanning the MHmm2 and ICHvc along Nelson Creek.

Table 6.2-9. Mapped MHmm2 Ecosystems in the RSA

Description	Map Code	Total Area	Percent of RSA
01 - HmBa - Blueberry	MB	7,471.0	3.5
02 - HmBa - Mountain-heather	MM	1,233.7	0.6
03 - BaHm - Oak fern	MO	412.5	0.2
04 - HmBa - Bramble	AB	451.2	0.2
05 - BaHm - Twistedstalk	MT	890.9	0.4
06 - HmYc - Deer cabbage	MD	8.1	0.0
07 - YcHm - Hellebore	YH	255.7	0.1
08 - HmYc - Sphagnum	YS	272.9	0.1
09 - YcHm - Skunk cabbage (Ws55 - YcHm - Skunkcabbage)	YC	227.2	0.1
Avalanche Herb Meadow	Vh	2,099.0	1.0
Avalanche Shrub Thicket | Shrubland (willow/alder thicket)	Vs | SW	4,098.8	1.9
Bog Wetland	Wb	206.1	0.1
Exposed Soil	ES	2,179.0	1.0
Glacier	GL	996.2	0.5
Herb Wetland (marsh and/or fen)	Wh	539.9	0.3
Pond	PD	182.1	0.1
Road	RZ	57.5	0.0
River	RI	350.9	0.2
Rock Outcrop (includes cliffs)	RO	542.8	0.3
Shrub Wetland (swamp and/or fen)	WE	231.2	0.1
Shrubland (willow/alder thicket)	SW	542.9	0.3
Swamp Wetland	Ws	67.6	0.0
Total		**23,317.0**	**11.0**

6.2.6 Mountain Hemlock - Moist Maritime Parkland

The MHmmp is a transitional parkland subzone that occurs above the MHmm1 and MHmm2. It is characterized by a discontinuous forest cover, with frequent avalanche slopes and interspersed with alpine communities such as alpine heath, lush herb meadows, and subalpine bogs and fens. Forested areas are limited to a single ecosystem classification (Parkland) and range from old to very old upperslope stands of mountain hemlock and subalpine fir, with understory vegetation including typical alpine species, to stunted, open stands of old trees on upper elevations and exposed slopes (Banner et al., 1993).

The MHmmp covers 20% of the RSA (42,342 hectares), occurring on upper slopes in all areas of the RSA. Only one forested ecosystem, Parkland, was modelled in the PEM covering 2.2% of the RSA, and an additional 0.6% in a mosaic with shrublands (Table 6.2-10). Most other vegetated communities modeled in the PEM followed the alpine classification system, with alpine fellfield the most commonly mapped (4.5% of the RSA). Shrub-dominated communities were common, including shrubland and avalanche ecosystems (Plate 6.2-16).

Table 6.2-10. Mapped MHmmp Ecosystems in the RSA

Description	Map Code	Total Area	Percent of RSA
Alpine Fellfield	Af	9624.6	4.5
Alpine Heath	Ah	4,081.8	1.9
Alpine Meadow	Am	6,980.8	3.3
Alpine Tundra	At	738.3	0.3
Alpine Wetland	Wa	224.6	0.1
Avalanche Shrub Thicket | Shrubland	Vs | Sc	1,139.1	0.5
Exposed Soil	ES	889.4	0.4
Krummholz	Sk	2,766.8	1.3
Parkland Forest	PK	4,612.8	2.2
Parkland Forest | Shrubland	PK | Sc	1,244.3	0.6
Permanent Snow and/or Glacier	PN | GL	5,878.0	2.8
Pond	PD	197.9	0.1
Road	RZ	1.1	0.0
River	RI	303.8	0.1
Rock Outcrop (includes cliffs)	RO	3,226.9	1.5
Shrubland	Sc	432.2	0.2
Total		**42,342.2**	**20.0**

The MHmmp accounted for 21.5% (3,404) of the LSA and 21% (203 hectares) of the PFSA (Table 6.2-11). This subzone is dominated by transitional ecosystems from the largely forested MHmm1 below to the CMAun alpine above. In the LSA, and even more so in the PFSA, the MHmmp is limited to a narrow extent of forested areas. Collectively called Parkland forest (3.4% of the LSA and 6.6% of the PFSA), these areas do not have formal ecosystem units (Plate 6.2-17). Parkland forests are typically old to very old forests as they occur on upper slopes that experienced an early retreat of glaciers relative to the valley bottom. At the upper elevation of parkland forests, they grade to an open canopy of smaller, stunted trees intermixed with alpine ecosystems such as alpine heath and meadows (Plates 6.2-18 and 6.2-19). As with the other BEC units in the LSA and PFSA, avalanche tracks are frequent and often extensive. They range from alder and willow dominated shrub thickets, to rich herb meadows, and occasional pockets of trees.

Plate 6.2-16. Looking down a small side valley of the Kshwan River in the southern portion of the RSA. The photo illustrates a typical MHmmp community that has established after relatively recent glacial retreat, but cold air drainage, persistent snowpack, and frequent avalanches have limited tree growth.

Plate 6.2-17. Old growth parkland forest in the MHmmp on steep, upper colluvial slopes above Bitter Creek.

Plate 6.2-18. Transition from stunted MHmmp parkland into alpine heath and krummholz on upper slopes above Bitter Creek.

Plate 6.2-19. Transition from MHmmp to CMAun in the RSA. Note the incised creek cutting through mounds of glacial till and the avalanche slopes along the sides of the creek with small, stunted subalpine fir and mountain hemlock.

Table 6.2-11. Mapped MHmmp Ecosystems in the Local and Project Footprint Study Areas

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
Floodplain	00/Fl	Low bench floodplain	3b	0.8	0.0	0.4	0.0
	00/Fm	Middle bench floodplain	3b	1.5	0.0	0.0	0.0
Parkland	00/Af	Alpine Fellfield	1a	68.2	0.4	0.0	0.0
	00/Ah	Alpine Heath	2d	23.7	0.1	0.8	0.1
	00/Am	Alpine Meadow	2a	212.3	1.3	0.0	0.0
	00/At	Alpine Tundra	2d	3.8	0.0	0.9	0.1
	00/PK	Parkland Forest	3b	0.0	0.0	2.4	0.2
			4	0.0	0.0	0.9	0.1
			5	89.7	0.6	29.7	3.1
			6	171.7	1.1	12.6	1.3
			7	281.0	1.8	17.5	1.8
	00/Sc	Shrubland	2d	0.0	0.0	3.4	0.4
			3a	179.4	1.1	13.8	1.4
			3b	93.5	0.6	1.9	0.2
	00/Sk	Krummholz	3a	80.3	0.5	0.2	0.0
			3b	108.1	0.7	0.5	0.0
			5	1.1	0.0	0.0	0.0
	00/SW	Shrubland (willow/alder thicket)	3a	0.0	0.0	21.0	2.2
			3b	0.0	0.0	55.2	5.7
	00/Vh	Avalanche Herb Meadow	2a	136.8	0.9	0.3	0.0
	00/Vs	Avalanche Shrub Thicket	3a	558.9	3.5	10.2	1.1
			3b	203.8	1.3	7.4	0.8
	00/Vt	Avalanche Treed	3a	6.2	0.0	0.0	0.0
			3b	10.4	0.1	0.1	0.0
			5	10.8	0.1	0.0	0.0
			6	0.0	0.0	0.9	0.1
Permanent Snow and/or Glacier	00/GL	Glacier		317.7	2.0	0.0	0.0
	00/PN	Permanent Snow		2.0	0.0	0.0	0.0
Sparsely Vegetated	00/As	Alpine Nivation (Late Snowbed)	1a	6.4	0.0	0.0	0.0
			2b	1.9	0.0	0.0	0.0
	00/Bl	Blockfield	1	0.8	0.0	0.0	0.0
	00/CB	Cutbank	1	1.5	0.0	0.0	0.0

General Ecosystem Type	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
	00/ES	Exposed Soil	1	233.2	1.5	7.4	0.8
	00/GB	Gravel bar	1	0.3	0.0	0.0	0.0
	00/MN	Moraine	1	3.8	0.0	0.0	0.0
	00/Rc	Cliff	1	162.2	1.0	3.8	0.4
	00/Ro	Rock Outcrop	1	164.5	1.0	5.4	0.6
	00/Rt	Talus	1	135.0	0.9	0.7	0.1
	00/RU	Rubble	1	82.6	0.5	0.3	0.0
Water	00/PD	Pond		1.0	0.0	0.0	0.0
	00/RI	River		34.1	0.2	5.2	0.5
Wetland	00/Wa	Alpine Wetland	2b	7.4	0.0	0.1	0.0
	00/Wb	Bog Wetland	5	7.2	0.0	0.0	0.0
Total				**3403.6**	**21.5**	**202.9**	**21.1**

6.2.7 Data Limitations

6.2.7.1 *Predictive Ecosystem Mapping*

There are several known limitations of the PEM:

- 30-m resolution of the DEM and Landsat used for initial modelling was larger than desired. This resulted in a final cell size that was coarse and likely generalized some features.
- SMR and SNR modelling results were biased towards mesic and medium conditions resulting in a higher percentage of mesic/medium ecosystem types and likely under-representing the wet dry ecosystems.
- Limited number of training sites. Additional training sites, especially given the large number of final ecosystem types, would be expected to increase the overall accuracy of the PEM.
- Inability to separate some ecosystem types (mainly different floodplains, avalanche slopes from edaphic shrub communities, different wetland classes except bogs, separating rock outcrops and cliffs). This resulted in the generalization of some ecosystem units.
- No Data. A small percentage of the initial modelling resulted in null data. These areas were combined into a no-data layer and merged with the final PEM and classified as NoData.
- Small, scattered polygons. Numerous small polygons with random ecosystem classifications are present throughout the PEM. While the overall and larger polygons (or accumulations of like polygons) are reasonably accurate, the small, scattered polygons generally have poor accuracy. These errors are directly related to the limitations (quality) of the DEM used for the project, and are consistent with other PEM projects reviewed in preparation for this this project.

6.2.7.2 *Terrestrial Ecosystem Mapping*

Mapping was completed using two sets of air photos (1994 and 2013) with a large portion of the study area covered by poor-quality, black-and-white imagery from 1994. The old imagery made accurate classification difficult, especially in non-forested areas, and did not contain some of the known anthropogenic disturbance in the western portion of the study area. The imagery did not fully cover the LSA, resulting in three un-mapped areas.

6.3 SENSITIVE ECOSYSTEMS

The following section describes the sensitive ecosystems mapped within the LSA (Figure 6.3-1) and PFSA (Figure 6.3-2). A summary of each sensitive ecosystem class is described below. When a given ecosystem unit falls under multiple sensitive ecosystem categories, it is presented on multiple tables (such as CWHwm 09/SC which is a blue-listed floodplain that was also mapped as mature and old forest in some areas).

6.3.1 Wetlands and Floodplains

Wetlands were uncommon in the Project area, accounting for 0.7% of the LSA and 0.1% of the PFSA (Table 6.3-1). Identified wetlands include swamps and fens that were classified to the site series level, along with marshes, swamps, fens, bog and alpine wetlands that could only be classified to the federal wetland class.

Floodplains were also uncommon in the Project area, accounting for 1.4% of the LSA and 7.6% of the PFSA (Table 6.3-2). Floodplain ecosystems included high, medium, and low bench floodplains. Only the CWHwm had floodplain ecosystems that could be classified to the site series level.

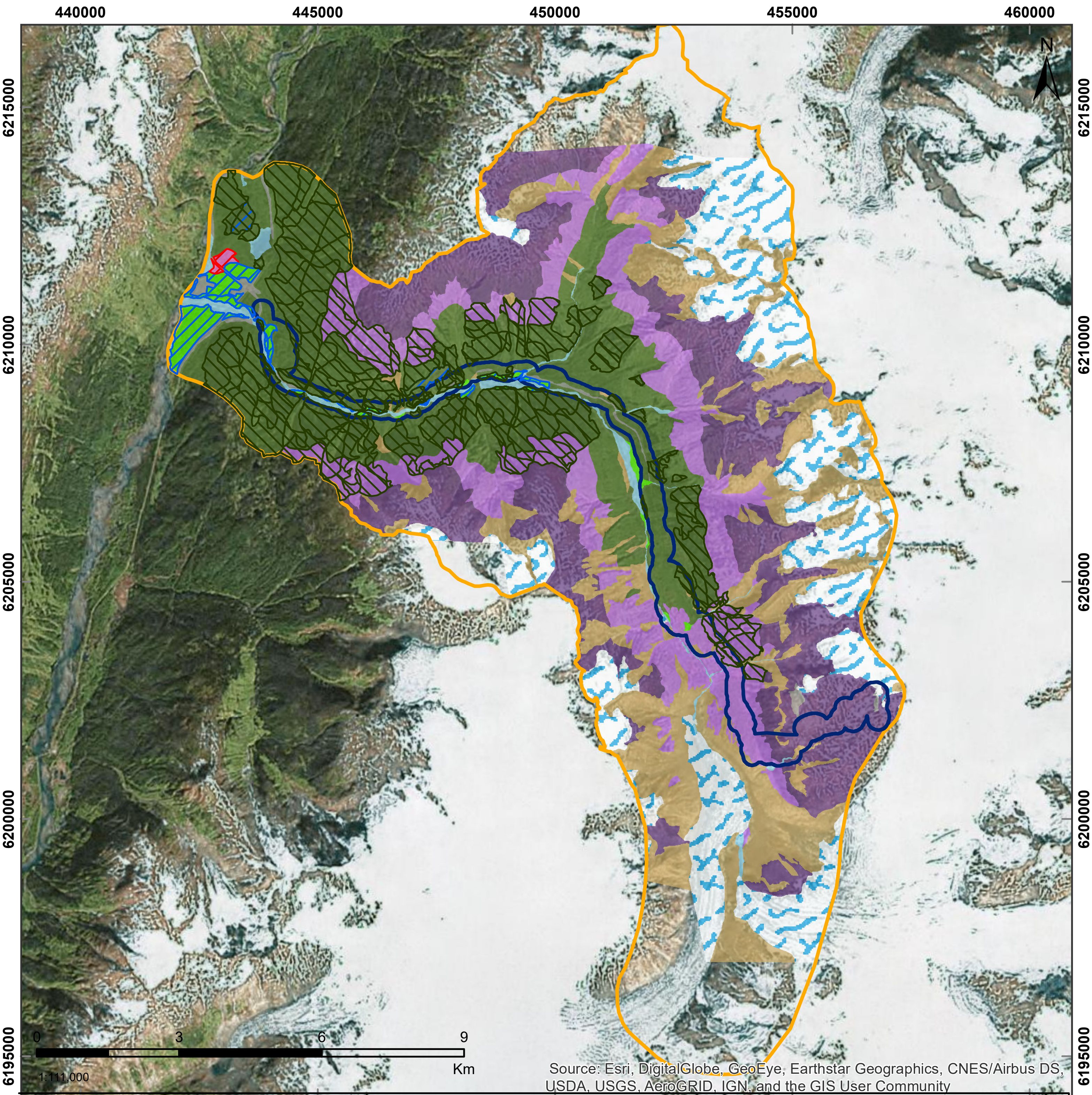
Table 6.3-1. Wetland Ecosystems Mapped within the LSA and PFSA

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
CMAun	00/Wa	Alpine wetland	2b	0.0	0.0	0.1	0.0
CWHwm	00/Wf	Fen Wetland	2b	0.0	0.0	0.2	0.0
	00/Wm	Marsh wetland	2b	1.1	0.0	0.0	0.0
	00/Ws	Swamp Wetland	2b	0.7	0.0	0.0	0.0
	09/SC	09 - Ss - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	4	12.4	0.1	0.0	0.0
			5	9.5	0.1	0.0	0.0
	Wf50/Wf50	Narrow-leaved cotton-grass - Peat-moss	2b	4.5	0.0	0.0	0.0
	Ws51/Ws51	Sitka Willow - Pacific Willow - Skunk Cabbage	3b	9.1	0.1	0.0	0.0

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
MHmm1	00/Wf	Fen Wetland	2b	23.0	0.1	0.6	0.1
	08/YS	08 - HmYc - Sphagnum	6	19.4	0.1	0.0	0.0
			7	17.9	0.1	0.0	0.0
	00/Wa	Alpine Wetland	2b	7.4	0.0	0.1	0.0
MHmmp	00/Wb	Bog Wetland	5	7.2	0.0	0.0	0.0
		Total		112.3	0.7	1.0	0.1

Table 6.3-2. Floodplain Ecosystems Mapped within the LSA and PFSA

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
CWHwm	00/Fl	Low bench floodplain	3a	0.0	0.0	0.7	0.1
			3b	0.0	0.0	0.0	0.0
	05/SS	05 - Ss - Salmonberry - high bench floodplain	3b	1.1	0.0	0.3	0.0
			4	3.7	0.0	5.2	0.5
			5	107.1	0.7	23.5	2.4
			6	8.2	0.1	5.1	0.5
			7	12.6	0.1	10.4	1.1
	06/CD	06 - Act - Red-osier dogwood - mid bench floodplain	3a	2.1	0.0	0.0	0.0
			3b	6.3	0.0	3.0	0.3
			4	0.0	0.0	11.2	1.2
			5	55.0	0.3	5.0	0.5
			6	1.0	0.0	2.4	0.2
			7	0.0	0.0	1.2	0.1
	07/CW	07 - Act - Willow	3a	1.3	0.0	0.0	0.0
			3b	9.6	0.1	0.0	0.0
MHmm1	00/Fl	Low bench floodplain	2d	3.6	0.0	0.3	0.0
			3a	2.3	0.0	1.2	0.1
			3b	7.0	0.0	0.0	0.0
	00/Fm	Middle bench floodplain	3b	0.0	0.0	3.4	0.4
			4	1.7	0.0	0.0	0.0
MHmmp	00/Fl	Low bench floodplain	3b	0.8	0.0	0.4	0.0
	00/Fm	Middle bench floodplain	3b	1.5	0.0	0.0	0.0
		Total		224.8	1.4	73.3	7.6



Red Mountain Underground Gold Project

Terrestrial Ecosystem Mapping within the Local Study Area

Figure 6.3-1

Date: 6/13/2017

Map Number: RM-046

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

ECOLOGIC environmental consulting

IDM MINING

Legend

Local Study Area

Project Footprint Study Area

Old/Mature Ecosystems

BC CDC Status

Blue-Listed

Red-Listed

General Ecosystem Type (Decile 1)

Permanent Snow and/or Glacier

Alpine

Parkland

Sparsely Vegetated

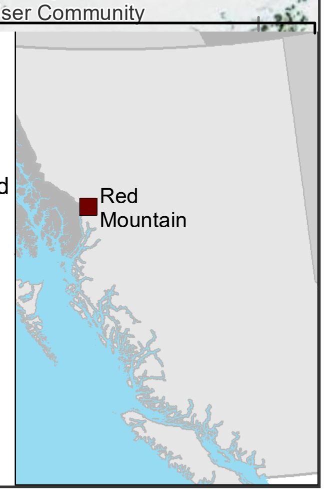
Forested

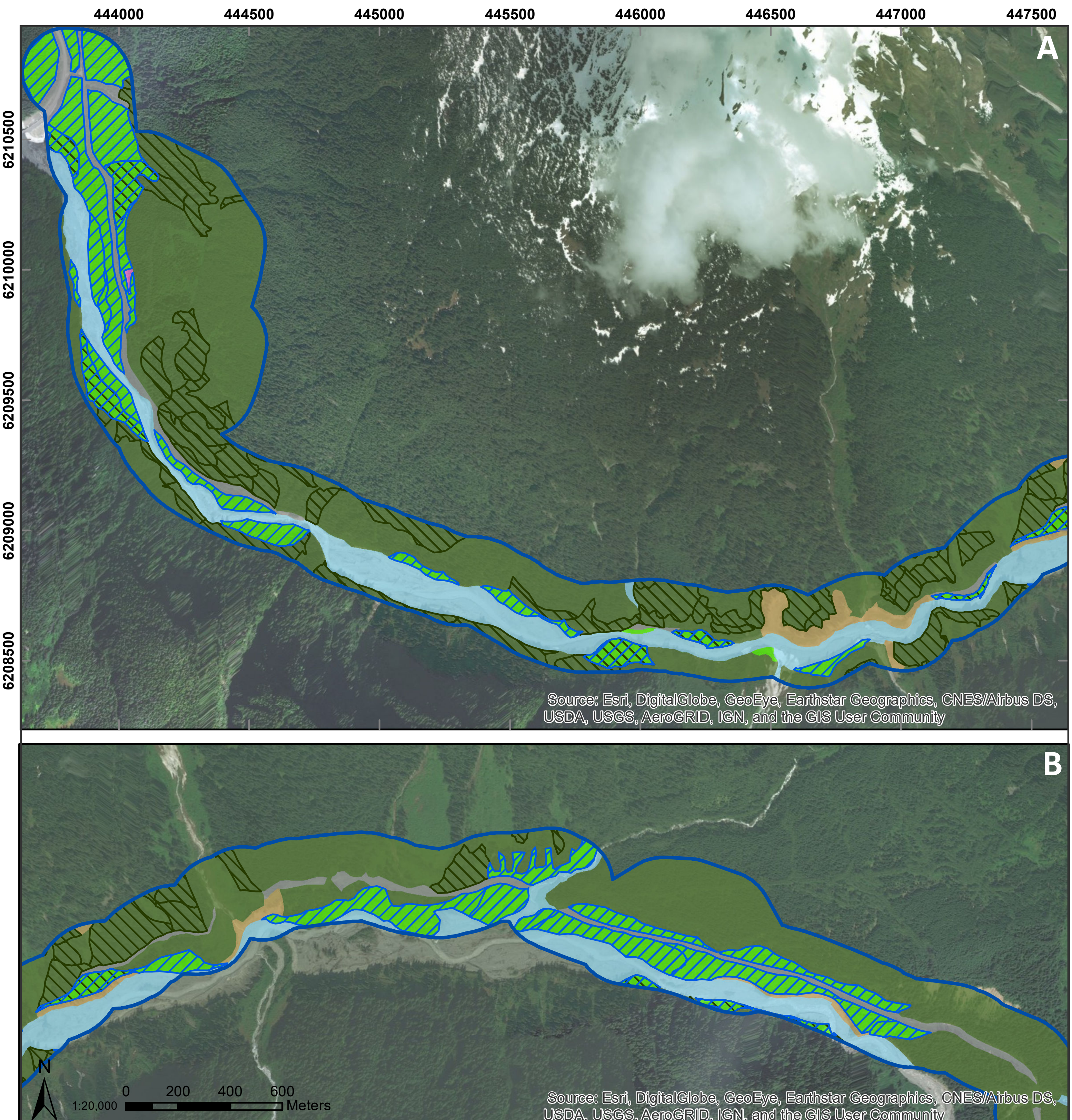
Floodplain

Anthropogenic

Wetland

Water





Red Mountain Underground Gold Project

General Ecosystem Types within the Project Footprint Study Area (Map 1 of 5)

Figure 6.3-2a

Date: 6/1/2017
Map Number: RM-050a
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

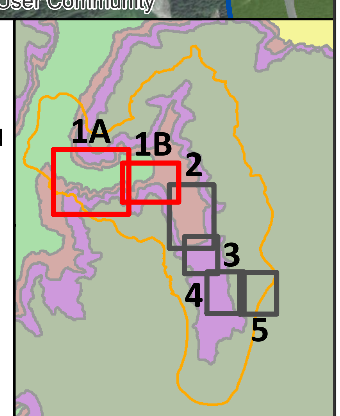
IDM MINING
ECOLOGIC environmental consulting

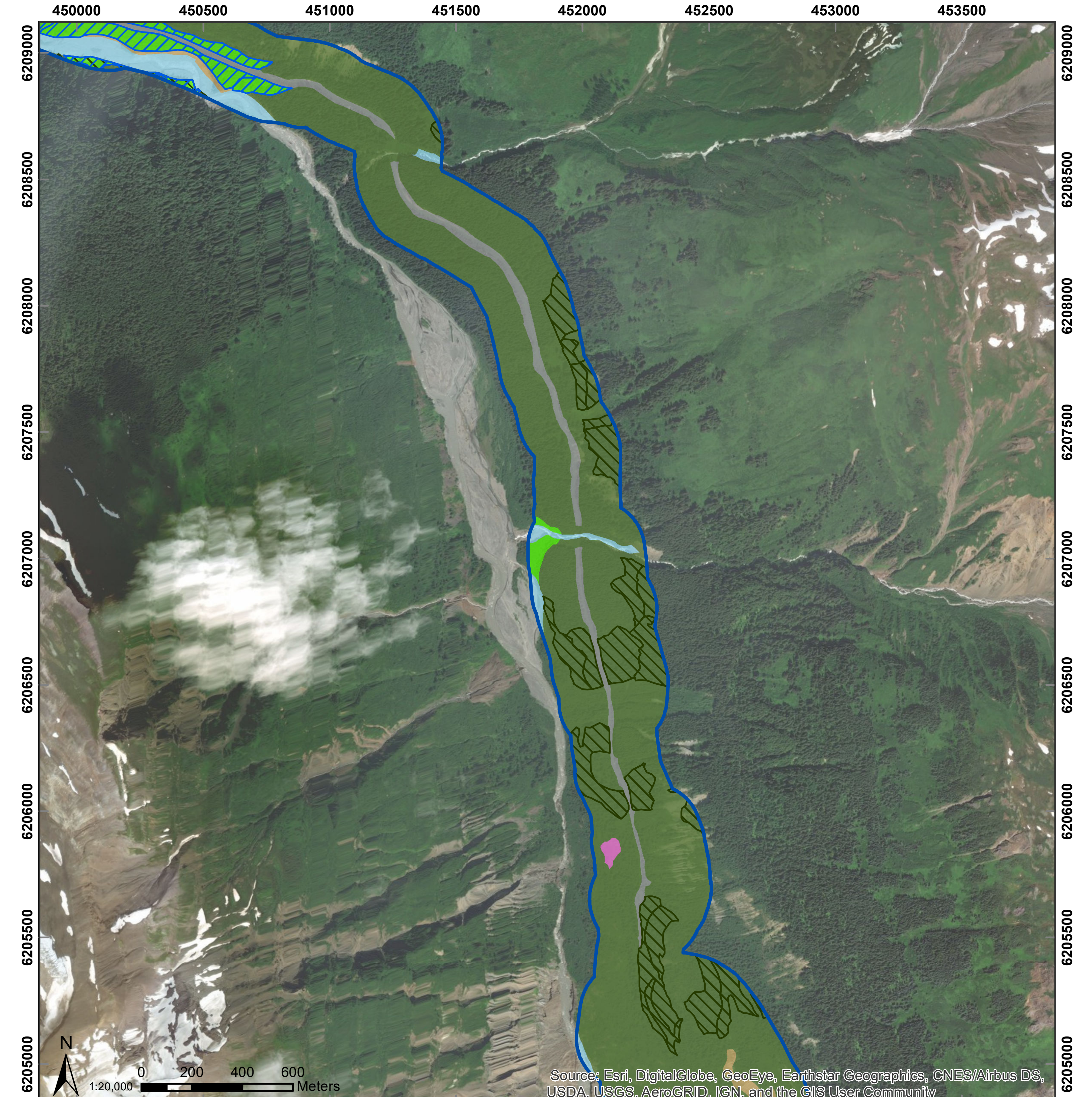
Legend

- Project Footprint Study Area
- Old/Mature Ecosystems
- BC CDC Blue-Listed

General Ecosystem Type (Decile 1)

- Permanent Snow and/or Glacier
- Alpine
- Parkland
- Sparsely Vegetated
- Forested
- Floodplain
- Anthropogenic
- Wetland
- Water





Red Mountain Underground Gold Project

General Ecosystem Types within the Project Footprint Study Area (Map 2 of 5)

Figure 6.3-2b

Date: 6/13/2017

Map Number: RM-050b

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

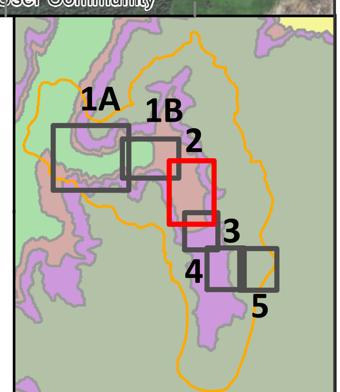
ECOLOGIC environmental consulting

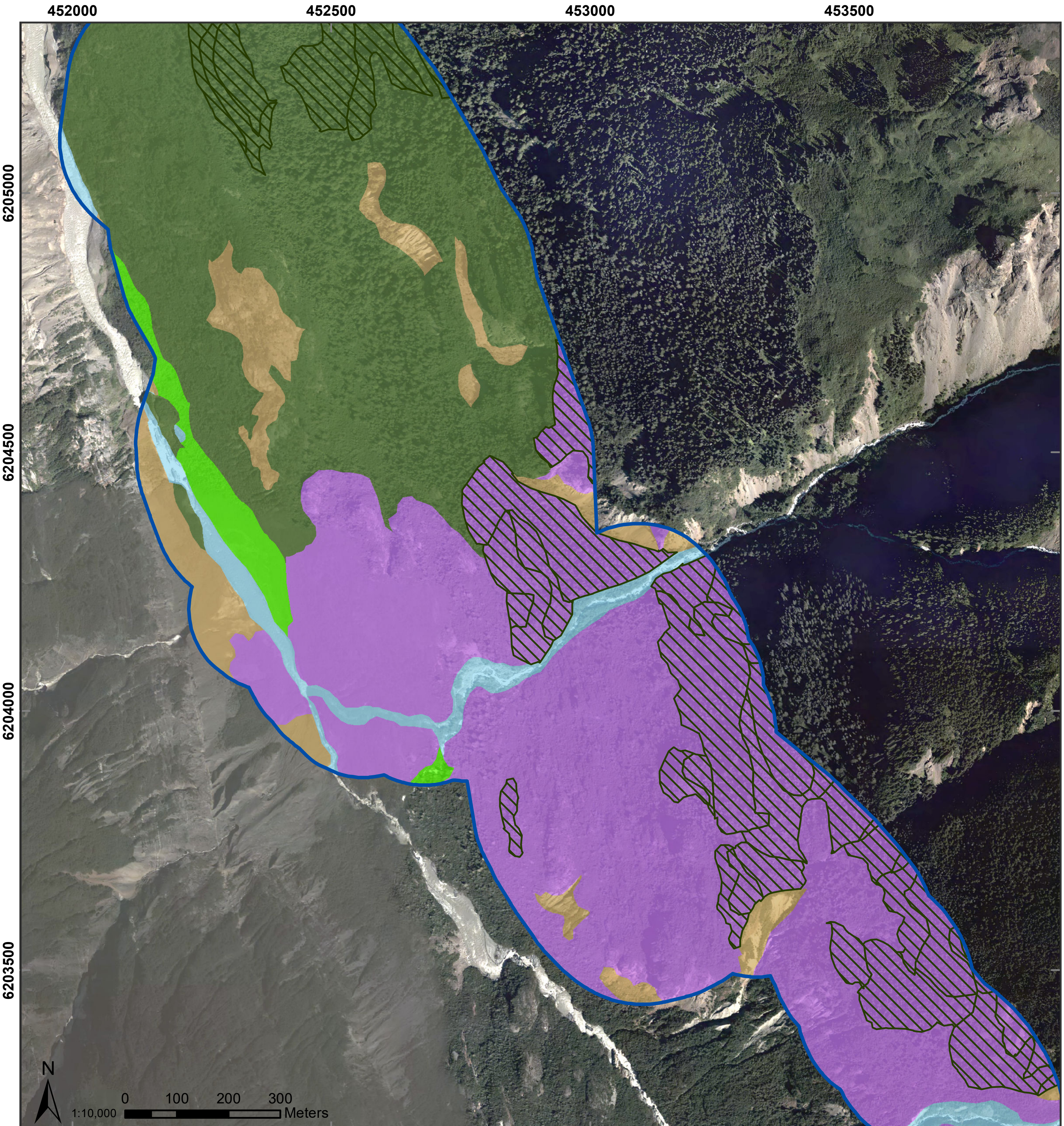
Legend

- Project Footprint Study Area
- BC CDC Blue-Listed
- Old/Mature Ecosystems

General Ecosystem Type (Decile 1)

- Permanent Snow and/or Glacier
- Alpine
- Parkland
- Sparsely Vegetated
- Forested
- Floodplain
- Anthropogenic
- Wetland
- Water





Red Mountain Underground Gold Project

General Ecosystem Types within the Project Footprint Study Area (Map 3 of 5)

Figure 6.3-2c

Date: 6/1/2017
Map Number: RM-050c
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

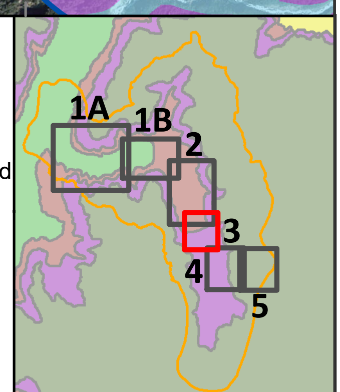
ECOLOGIC environmental consulting

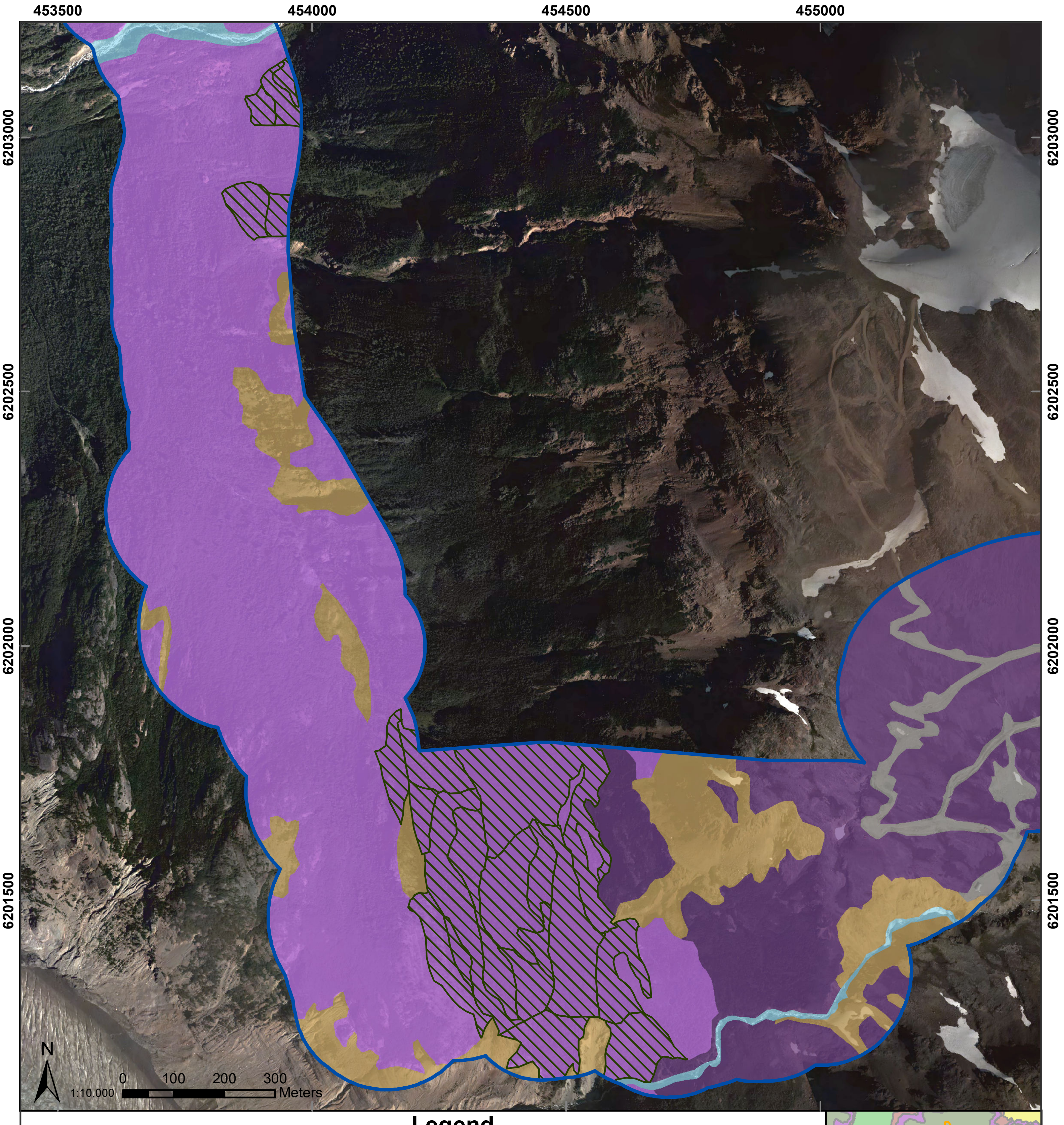
Legend

- Project Footprint Study Area
- BC CDC Blue-Listed
- Old/Mature Ecosystems

General Ecosystem Type (Decile 1)

- Permanent Snow and/or Glacier
- Alpine
- Parkland
- Sparsely Vegetated
- Forested
- Floodplain
- Anthropogenic
- Wetland
- Water





Red Mountain Underground Gold Project

General Ecosystem Types within the Project Footprint Study Area (Map 4 of 5)

Figure 6.3-2d

Date: 6/1/2017
Map Number: RM-050d
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

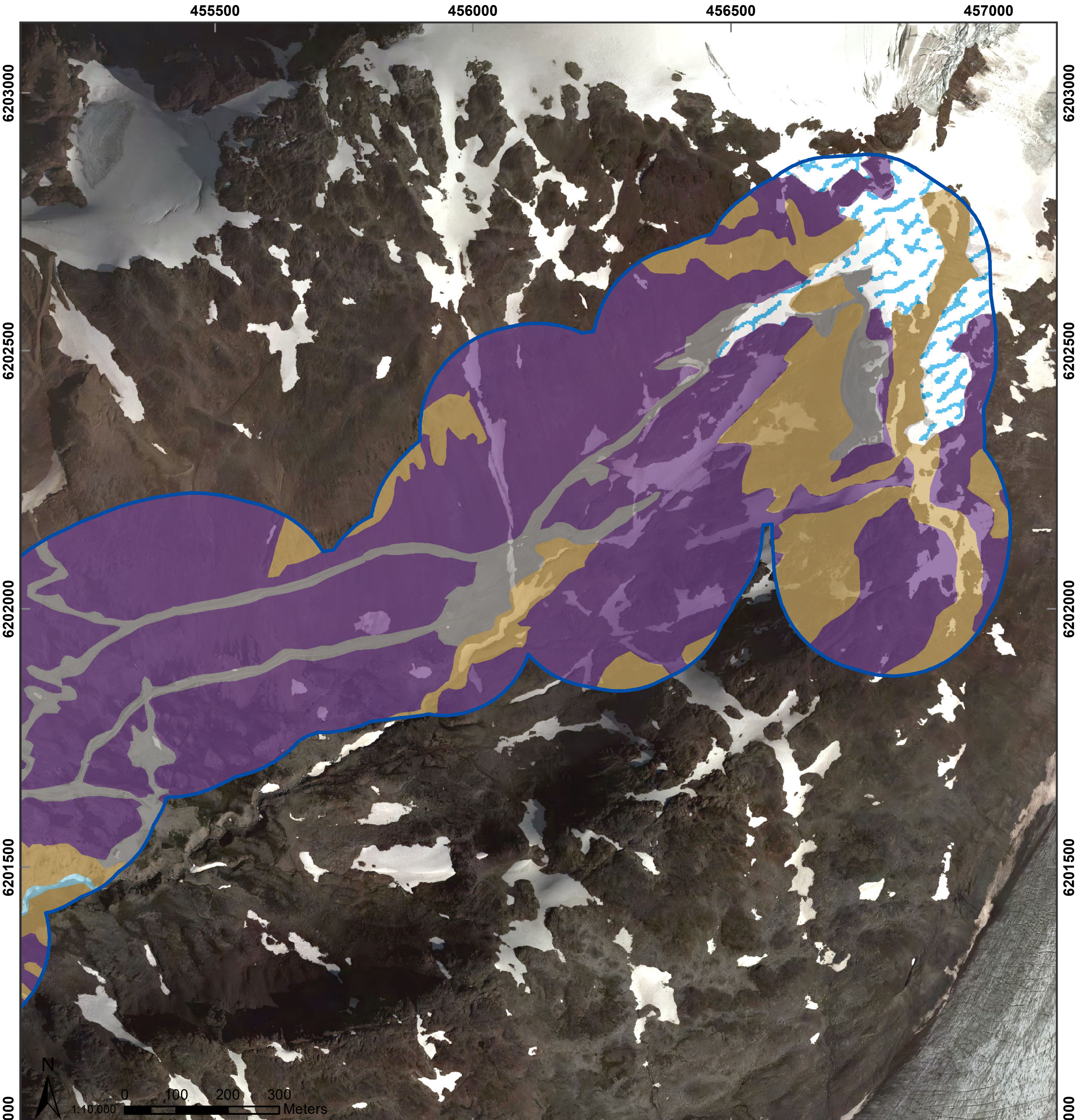
IDM MINING
ECOLOGIC environmental consulting

Legend

- Project Footprint Study Area
- BC CDC Blue-Listed
- Old/Mature Ecosystems

General Ecosystem Type (Decile 1)

- Permanent Snow and/or Glacier
- Alpine
- Parkland
- Sparsely Vegetated
- Forested
- Floodplain
- Anthropogenic
- Wetland
- Water



Red Mountain Underground Gold Project

General Ecosystem Types within the Project Footprint Study Area (Map 5 of 5)

Figure 6.3-2e

Date: 6/1/2017
Map Number: RM-050e
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

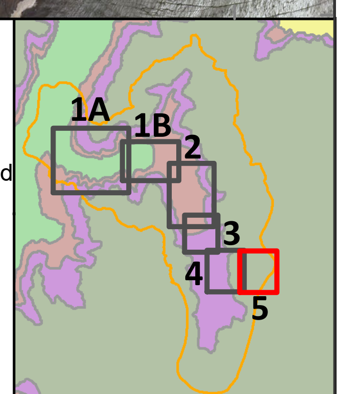
IDM MINING
ECOLOGIC environmental consulting

Legend

- Project Footprint Study Area
- BC CDC Blue-Listed
- Old/Mature Ecosystems

General Ecosystem Type (Decile 1)

- Permanent Snow and/or Glacier
- Alpine
- Parkland
- Sparsely Vegetated
- Forested
- Floodplain
- Anthropogenic
- Wetland
- Water



6.3.2 Mature and Old Forest

Mature and old forests were mapped in all of the forested BEC zones in the Project area, accounting for 15.0% of the LSA and 21.3% of the PFSA (Table 6.3-3) and occurring in all but the CMAun. Forested ecosystems from the MHmmp that were mapped as structural stage five (young forest) were included in this category as they likely represented mature or old trees that will never reach a classic structural stage due to environmental conditions.

Table 6.3-3. Mature and Old Forest Ecosystems Mapped within the LSA and PFSA

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
CWHwm	01/HB	01 - HwSs - Blueberry	6	201.7	1.3	15.8	1.6
			7	161.8	1.0	3.7	0.4
	02/HM	02 - HwSs - Step moss	6	13.6	0.1	0.0	0.0
	03/SO	03 - SsHw - Oak fern	6	141.4	0.9	7.3	0.8
			7	228.5	1.4	21.6	2.2
	04/SD	04 - SsHw - Devil's club	6	74.1	0.5	17.7	1.8
			7	78.0	0.5	17.3	1.8
	05/SS	05 - Ss - Salmonberry - high bench floodplain	6	8.2	0.1	5.1	0.5
			7	12.6	0.1	10.4	1.1
	06/CD	06 - Act - Red-osier dogwood - mid bench floodplain	6	1.0	0.0	2.4	0.2
			7	0.0	0.0	1.2	0.1
MHmm1	01/MB	01 - HmBa - Blueberry	6	243.3	1.5	5.4	0.6
			7	280.7	1.8	0.0	0.0
	02/MM	02 - HmBa - Mountain-heather	7	0.6	0.0	0.0	0.0
	03/MO	03 - BaHm - Oak fern	6	129.1	0.8	19.2	2.0
			7	67.0	0.4	2.5	0.3
	04/AB	04 - HmBa - Bramble	6	11.6	0.1	0.0	0.0
	05/MT	05 - BaHm - Twistedstalk	6	14.4	0.1	14.6	1.5
			7	27.8	0.2	0.0	0.0
	06/MD	06 - HmYc - Deer cabbage	7	22.6	0.1	0.0	0.0
	07/YH	07 - YcHm - Hellebore	6	23.8	0.2	0.0	0.0
			7	39.5	0.2	0.0	0.0
	08/YS	08 - HmYc - Sphagnum	6	19.4	0.1	0.0	0.0

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
			7	17.9	0.1	0.0	0.0
MHmmp	00/Pk	Parkland Forest	5	89.7	0.6	29.7	3.1
			6	171.7	1.1	12.6	1.3
			7	281.0	1.8	17.5	1.8
	00/Vt	Avalanche Treed	5	10.8	0.1	0.0	0.0
			6	0.0	0.0	0.9	0.1
		Total		2371.8	15.0	204.8	21.3

6.3.3 Alpine and Parkland

Alpine ecosystems cover a large portion of the Project area, with vegetated units accounting for 19.2% of the LSA and 11.1% of the PFSA (Table 6.3-4). Vegetated alpine ecosystems were only mapped in the CMAun. Parkland ecosystems were also common in the Project area (mapped in the MHmmp), with vegetated units accounting for 14.1% of the LSA and 18.7% of the PFSA (Table 6.3-5).

Table 6.3-4. Vegetated Alpine Ecosystems Mapped within the LSA and PFSA

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
CMAun	00/Af	Alpine Fellfield	1a	1324.9	8.4	59.6	6.2
	00/Ah	Alpine Heath	2d	384.2	2.4	17.5	1.8
	00/Am	Alpine Meadow	2a	473.2	3.0	0.0	0.0
	00/As	Alpine Nivation (Late Snowbed)	1a	415.4	2.6	0.8	0.1
			2b	19.8	0.1	0.2	0.0
	00/At	Alpine Tundra	2d	203.7	1.3	21.6	2.2
	00/Sc	Shrub carr	3a	7.7	0.0	0.0	0.0
	00/Sk	Krummholz	3a	121.0	0.8	5.0	0.5
			3b	26.0	0.2	2.4	0.2
	00/Vh	Avalanche Herb Meadow	2a	16.3	0.1	0.0	0.0
	00/Vs	Avalanche Shrub Thicket	3a	37.1	0.2	0.0	0.0
			3b	7.9	0.0	0.0	0.0
		Total		3037.4	19.2	107.0	11.1

Table 6.3-5. Vegetated Parkland Ecosystems Mapped within the LSA and PFSA

BEC Unit	Site Series/ Map Code	Ecosystem Description	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
MHmmp	00/Af	Alpine Fellfield	1a	68.2	0.4	0.0	0.0
	00/Ah	Alpine Heath	2d	23.7	0.1	0.8	0.1
	00/Am	Alpine Meadow	2a	212.3	1.3	0.0	0.0
	00/At	Alpine Tundra	2d	3.8	0.0	0.9	0.1
	00/PK	Parkland Forest	3b	0.0	0.0	2.4	0.2
			4	0.0	0.0	0.9	0.1
			5	89.7	0.6	29.7	3.1
			6	171.7	1.1	12.6	1.3
			7	281.0	1.8	17.5	1.8
	00/Sc	Shrubland (dry)	2d	0.0	0.0	3.4	0.4
			3a	179.4	1.1	13.8	1.4
			3b	93.5	0.6	1.9	0.2
	00/Sk	Krummholz	3a	80.3	0.5	0.2	0.0
			3b	108.1	0.7	0.5	0.0
			5	1.1	0.0	0.0	0.0
	00/SW	Shrubland (willow/alder thicket)	3a	0.0	0.0	21.0	2.2
			3b	0.0	0.0	55.2	5.7
	00/Vh	Avalanche Herb Meadow	2a	136.8	0.9	0.3	0.0
	00/Vs	Avalanche Shrub Thicket	3a	558.9	3.5	10.2	1.1
			3b	203.8	1.3	7.4	0.8
	00/Vt	Avalanche Treed	3a	6.2	0.0	0.0	0.0
			3b	10.4	0.1	0.1	0.0
			5	10.8	0.1	0.0	0.0
			6	0.0	0.0	0.9	0.1
		Total		2239.7	14.1	179.6	18.7

6.3.4 BC CDC Listed Ecosystems

Five listed ecosystems were identified in the LSA (1.7%) and two in the PFSA (7.0%). The listed ecosystems (all occurring within the CWHwm) included two blue-listed floodplains, one red-listed and one blue-listed wetland, and one blue-listed forested ecosystem (Table 6.3-6).

Table 6.3-6. BC CDC Listed Ecosystems Mapped within the LSA and PFSA

BEC Unit	Site Series/ Map Code	Ecosystem Description	Provincial Status	Structural Stage	LSA Extent (ha)	LSA Extent (%)	PFSA Extent (ha)	PFSA Extent (%)
CWHwm	02/HM	02 - HwSs - Step moss	Blue	5	18.1	0.1	0.0	0.0
				6	13.6	0.1	0.0	0.0
	05/SS	05 - Ss - Salmonberry - high bench floodplain	Blue	3b	1.1	0.0	0.3	0.0
				4	3.7	0.0	5.2	0.5
				5	107.1	0.7	23.5	2.4
				6	8.2	0.1	5.1	0.5
				7	12.6	0.1	10.4	1.1
	06/CD	06 - Act - Red-osier dogwood - mid bench floodplain	Blue	3a	2.1	0.0	0.0	0.0
				3b	6.3	0.0	3.0	0.3
				5	55.0	0.3	5.0	0.5
				6	1.0	0.0	2.4	0.2
				4	0.0	0.0	11.2	1.2
				7	0.0	0.0	1.2	0.1
	07/CW	07 - Act - Willow	Blue	3a	1.3	0.0	0.0	0.0
				3b	9.6	0.1	0.0	0.0
	09/SC	09 - Ss - Skunk cabbage (Ws54 - CwHw - Skunk cabbage)	Blue	4	12.4	0.1	0.0	0.0
				5	9.5	0.1	0.0	0.0
				3a	0.0	0.0	0.4	0.0
	Ws51/Ws51	Sitka Willow - Pacific Willow - Skunk Cabbage	Red	3b	9.1	0.1	0.0	0.0
		Total			270.7	1.7	67.6	7.0

6.4 SOILS MAPPING AND CLASSIFICATION

Soil formation in the Project area is limited by recent glacial recession, cold climate and high rates of natural disturbance. Biological and chemical soil-forming processes dependent on soil temperature thresholds only occur during a brief seasonal window, and steep slopes limit pedogenesis due to constant downslope movement through solufluction, soil creep, surface erosion, and mass movement. Soils that develop in colluvial and morainal surficial materials dominate the LSA and PFSA; soils derived from fluvial, glaciofluvial, glaciocolluvial (combination of glacial till and downward postglacial material movement) are also common. Less common materials are poorly drained organic materials and associated wetlands, shallow weathered bedrock materials (saprolite) and shallow open water (ponds).

The dominant mineral soils described in the LSA and PFSA are weakly-moderately developed, and include moderately developed brown coloured Brunisols and weakly developed Regosols. Other, but less common, mineral soils are Humo-Ferric Podzols, which have more intense red-orange diagnostic "Bf" horizon colours and occur more often in higher elevation areas, and in soils with coarse gravelly sandy textures. Poorly drained Gleysols are less common, but do occur in lower/toe slope positions on the landscape and adjacent to creek or river deposits and, under rare and thin organic soil deposits (where the depth of organic matter is minimal and does not preclude the designation of the Podzol order). A few organic soils were described in valley bottoms and depression slope positions. They include moderately decomposed Mesisols of varying thickness.

6.4.1 Soil Map Units

A total of 22 SMUs were established in the PFSA for the Project. Soil mapping terminology are defined in Describing Ecosystems in the Field 2nd Edition (Prov. of BC 2010) and the Canadian System of Soil Classification (1998). The six most common SMUs (Table 6.4-1; Figures 6.4-1a through 6.4-1e) have the following characteristics.

- **SMU6** (122.5 ha, 12.8% area; shallow till, colluvium, saprolite often 30 to 50 cm to rock);
- **SMU1a** (85.3 ha, 8.9% area, coarse till/colluvium blankets greater than 1 m, "average" mesic sites);
- **SMU 6c** (81.0 ha, 8.4% area, lower/toe slope position colluvium);
- **SMU7d** (77.4 ha, 8.1% area, alpine-sub-alpine tundra with heather, sparse lichen/grass);
- **SMU8a** (71.6 ha, 7.4% area, large inactive fluvial terraces); and
- **SMU8b** (71.2 ha, 7.4% area, large active flowing creeks in the valley bottom, e.g., Bitter Creek).

Table 6.4-1. Area Extent of Each Soil Map Unit (SMU) in the Red Mountain Project PFSA

SMU	Area (ha)	Percent
1a	85.3	8.9
1b	24.3	2.5
1c	11.1	1.2
4	33.4	3.5
4a	44.0	4.6
4b	13.0	1.4
4c	0.5	0.0
5	25.5	2.7
5a	29.5	3.1
6	122.5	12.8

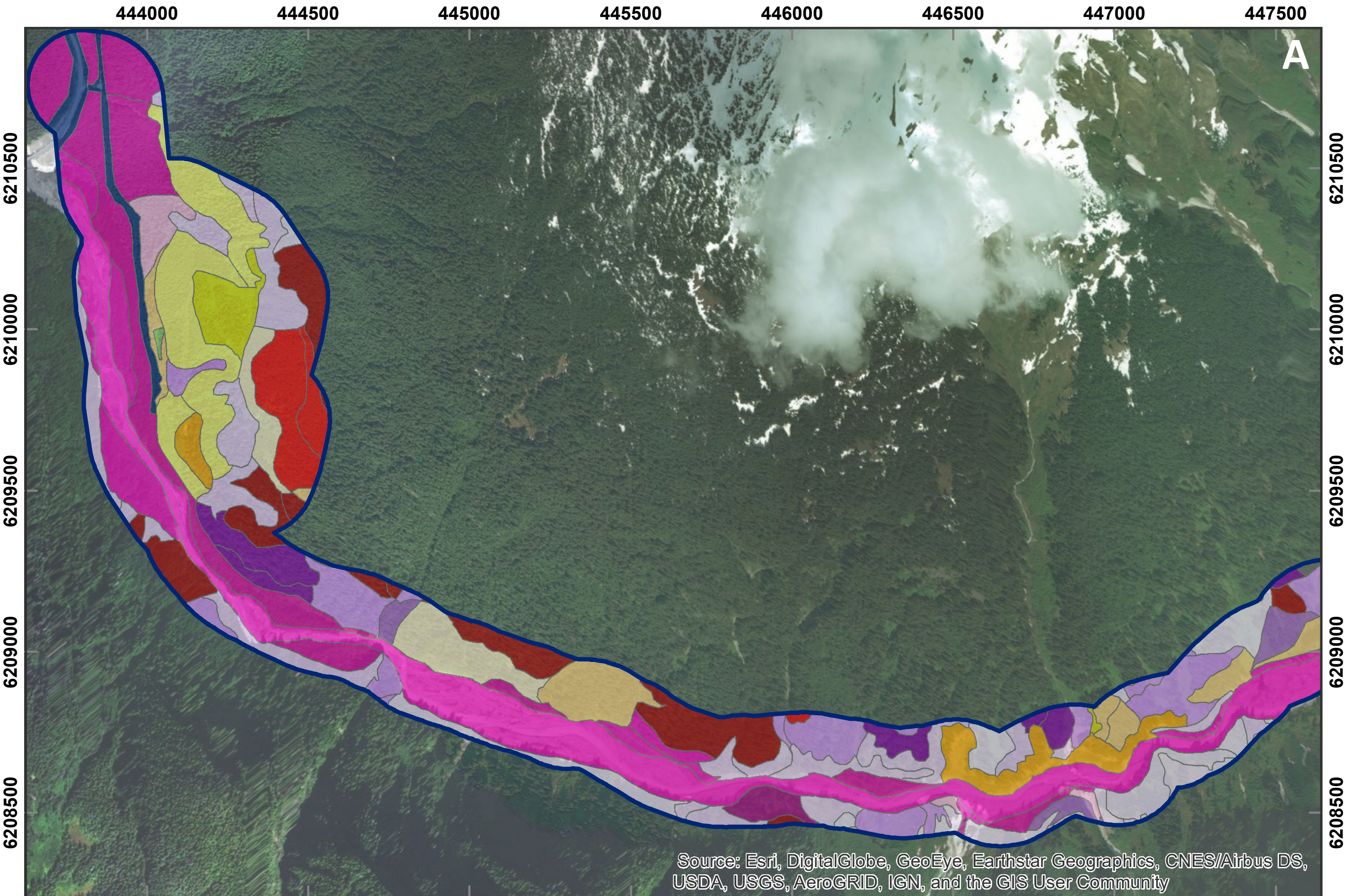
SMU	Area (ha)	Percent
6a	12.0	1.3
6b	73.2	7.6
6c	81.0	8.4
6d	60.1	6.3
6e	1.5	0.2
7a	20.8	2.2
7b	4.6	0.5
7c	0.2	0.0
7d	77.4	8.1
8	7.4	0.8
8a	71.6	7.4
8b	71.2	7.4
8c	9.9	1.0
A	21.1	2.2
I	16.9	1.8
RI	0.4	0.0
RO	42.4	4.4
Total	960.7	100.0

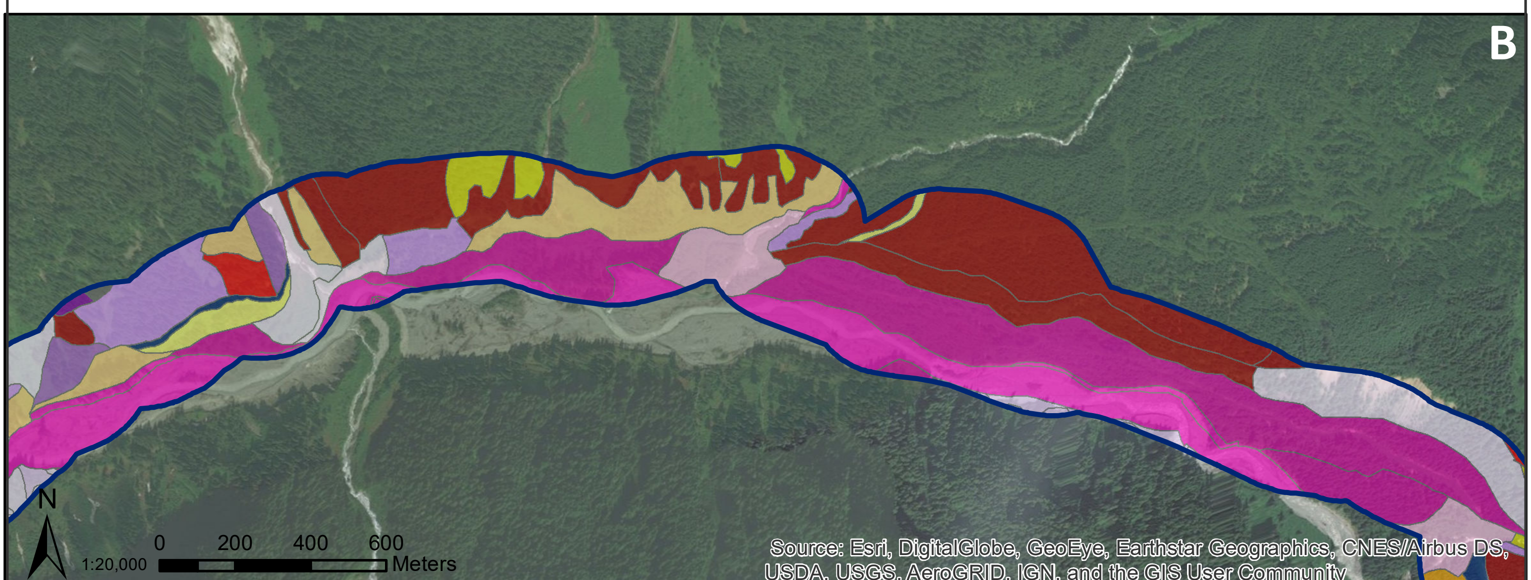
SMU 1a

SMU 1a soils represent average mid-slope mesic sites. They are well to rapidly drained, coarse textured deep soils often of sandy, silty (dominantly loamy sand) and gravelly in texture and derived from glacial till and colluvium materials (Plate 6.4-1). SMU 1a soils are found on mesic or average sites with average to below-average nutrients and fresh or moist soil moisture. Soils in the SMU 1a type are mainly glacial till blankets (greater than 1m depth), have slope gradients ranging from gentle to steep (e.g., 15 to 50% slope gradient) and occur in all slope positions. Coarse fragment content ranges from 20 to 50%. Typical soil classification (CSSC 1998) for this type includes O.HFP, EL.DYB, O.DYB, and O.EB.

SMU 1b

SMU 1b soils occur on mid to lower slope positions and include moisture receiving slope positions. They support ecosystems with generally higher available nutrients and productivity. Soil textures range from loamy (L-SL) - SiL tills on 5 to 40% slope gradient. Soils of this type mainly on lower-toe slope position, and as such, have slightly higher organic matter content (Plate 6.4-1). Ah horizons are generally less than 0 to 5 cm in depth and can include somewhat richer intermixed soil materials owing to slope movement. Soils are moist but not saturated for long duration, thus gleying and intense mottling are not a common soil feature of this SMU type (but does occur





Red Mountain Underground Gold Project

Soil Units within the Project Footprint Study Area (Map 1 of 5)

Figure 6.4-1a

Date: 6/6/2017
Map Number: RM-058a
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

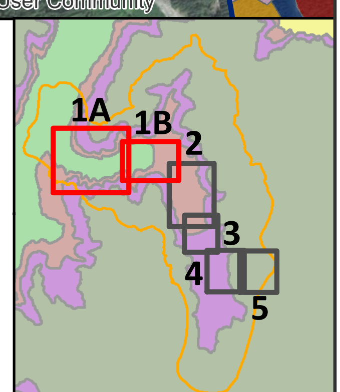
ECOLOGIC environmental consulting

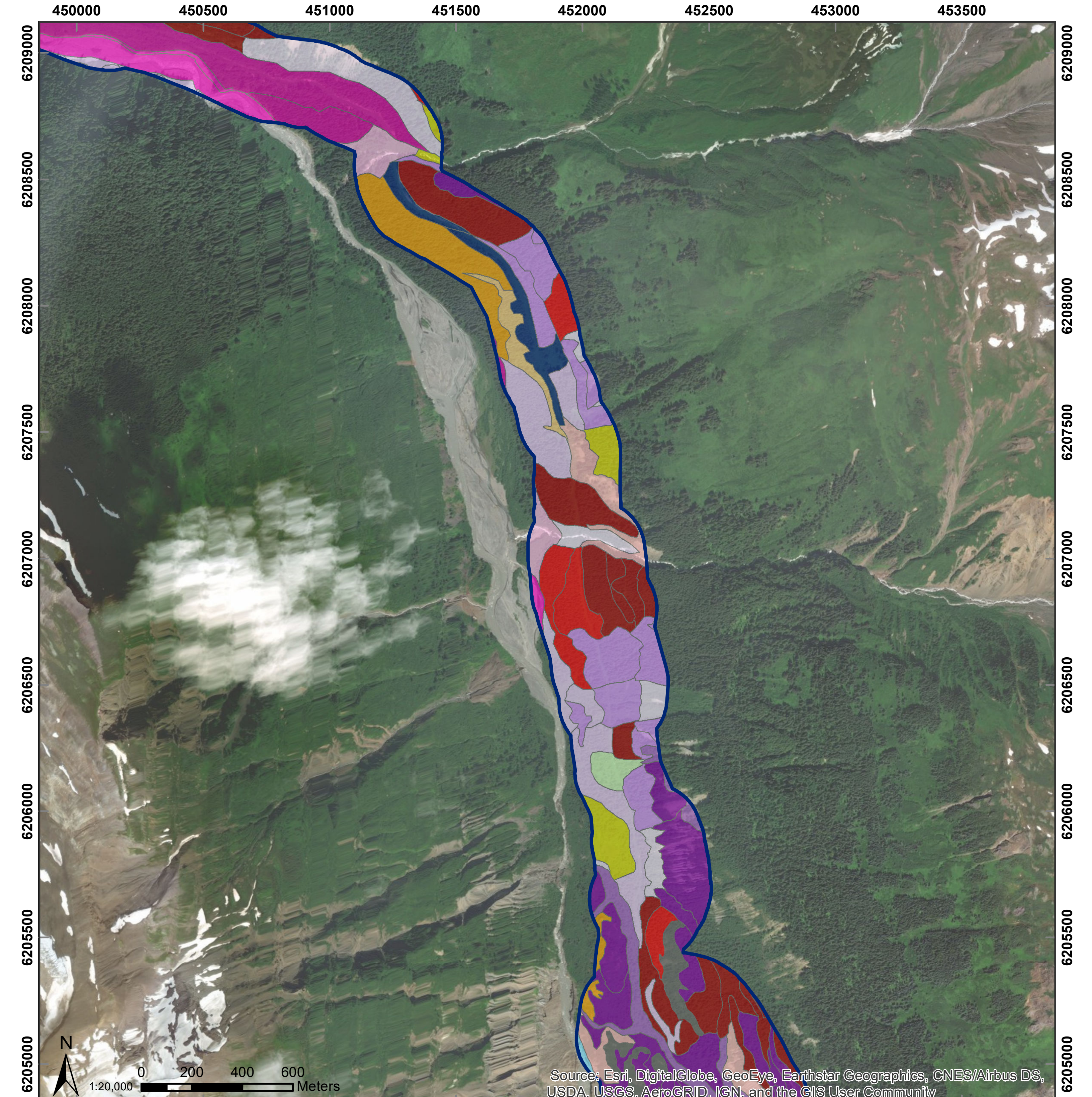
Legend

PFSA

SMU

1a, 1b, 1c, 4, 4a, 4b, 5, 5a, 6, 6a, 6b, 6c, 6d, 7a, 7c, 7d, 8, 8a, 8b, 8c, A, I, RI, RO





Red Mountain Underground Gold Project

Soil Units within the Project Footprint Study Area (Map 2 of 5)

Figure 6.4-1b

Date: 6/6/2017

Map Number: RM-058b

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

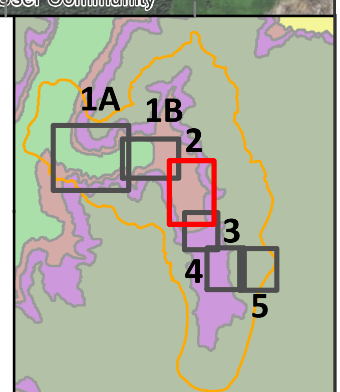
ECOLOGIC environmental consulting

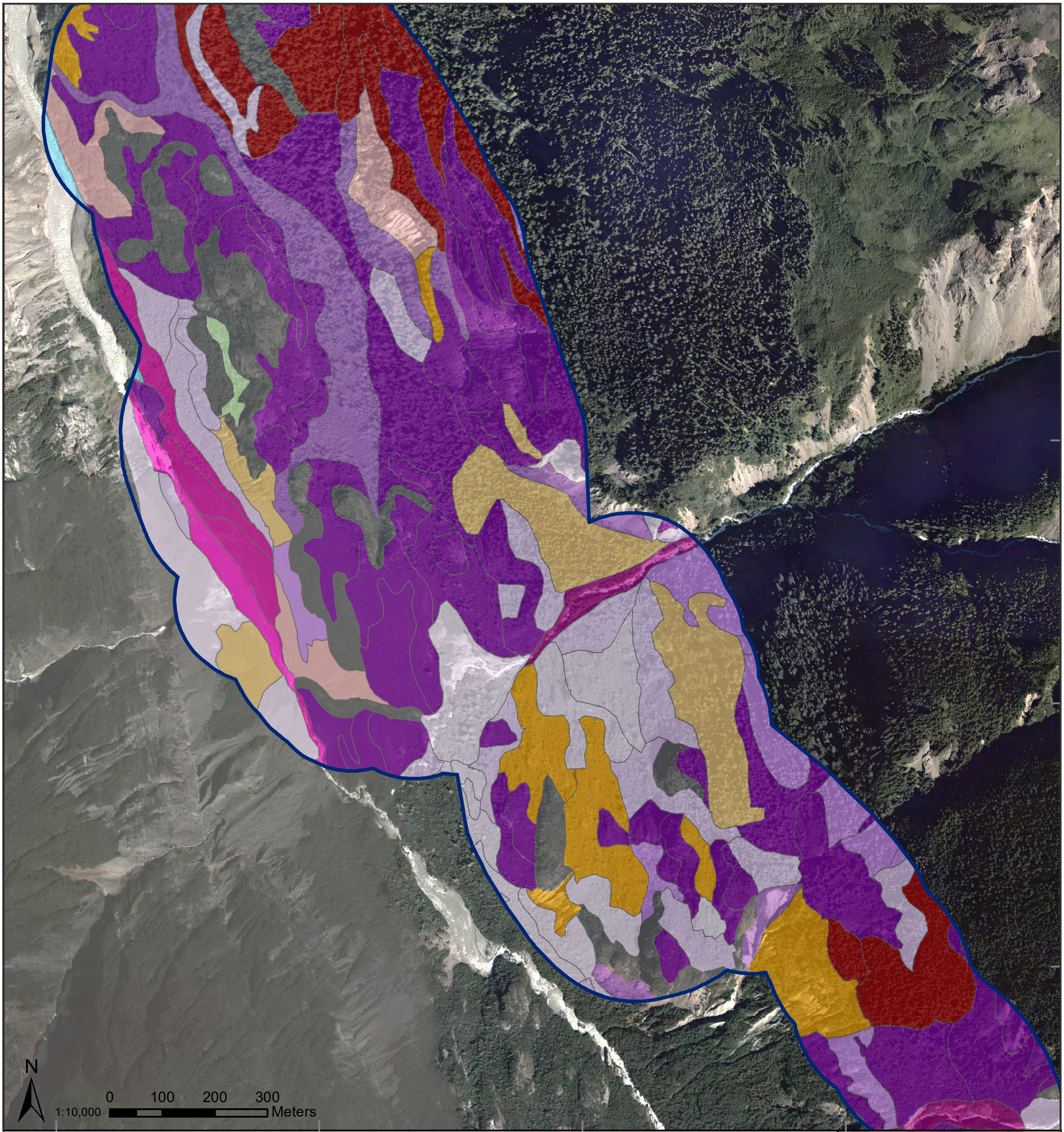
Legend

PFSA

SMU

1a
1b
1c
4
4a
4b
5
5a
6
6a
6b
6c
6d
7a
7c
7d
8
8a
8b
8c
A
I
RI
RO





Red Mountain Underground Gold Project

Soil Units within the Project Footprint Study Area (Map 3 of 5)

Figure 6.4-1c

Date: 6/6/2017

Map Number: RM-058c

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

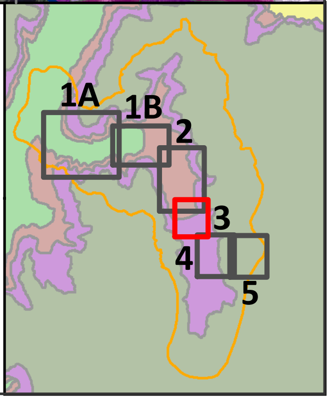
ECOLOGIC environmental consulting

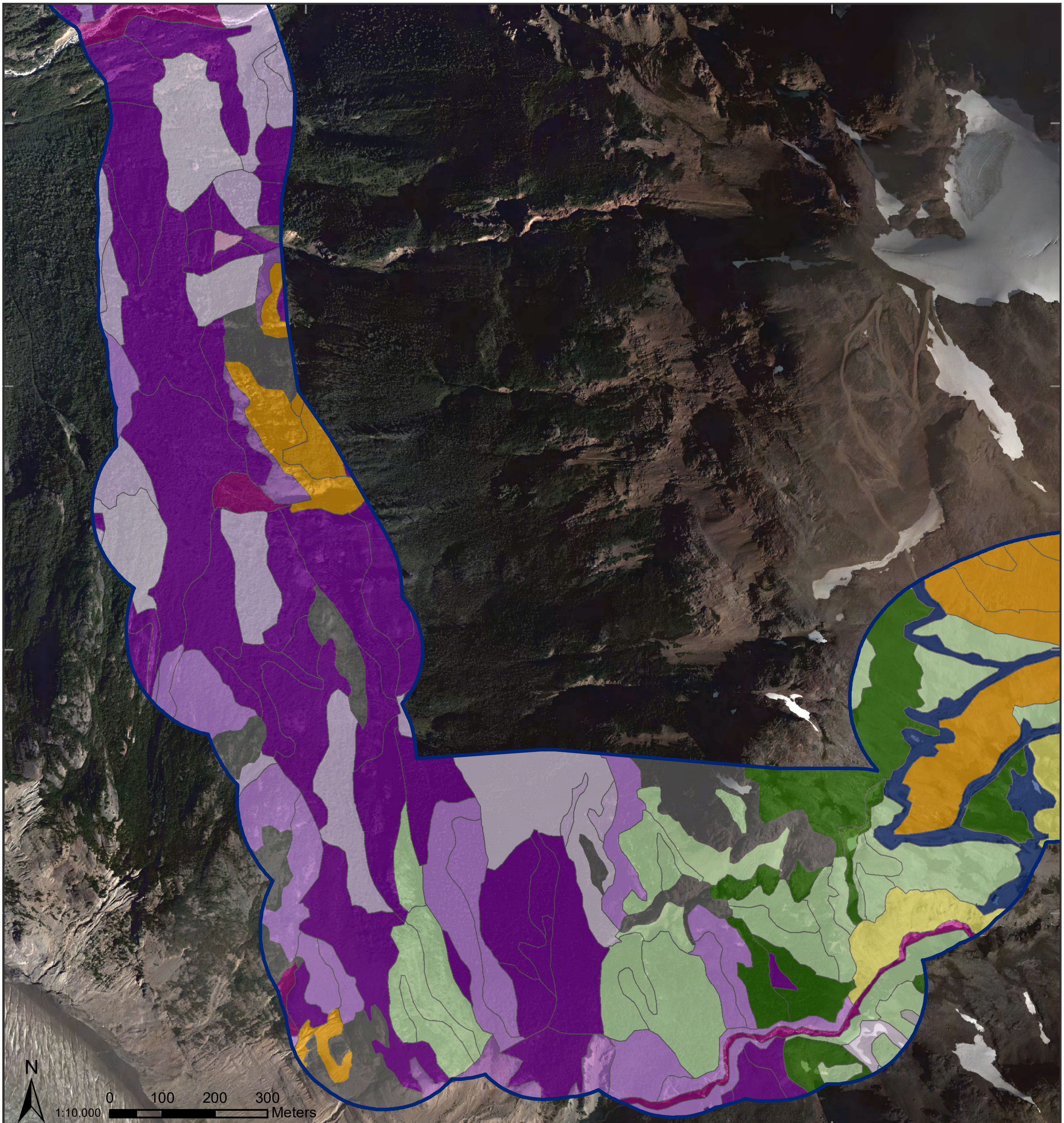
Legend

PFSA

SMU

1a, 1b, 1c, 4, 4a, 4b, 5, 5a, 6, 6a, 6b, 6c, 6d, 7a, 7c, 7d, 8, 8a, 8b, 8c, A, I, RI, RO





Red Mountain Underground Gold Project

Soil Units within the Project Footprint Study Area (Map 4 of 5)

Figure 6.4-1d

Date: 6/6/2017
Map Number: RM-058d
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

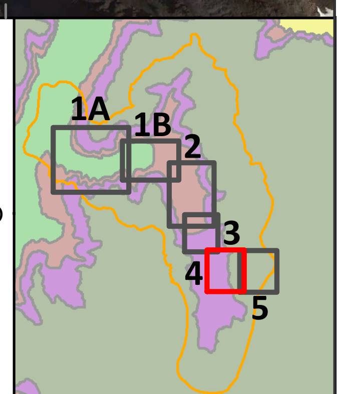
ECOLOGIC environmental consulting

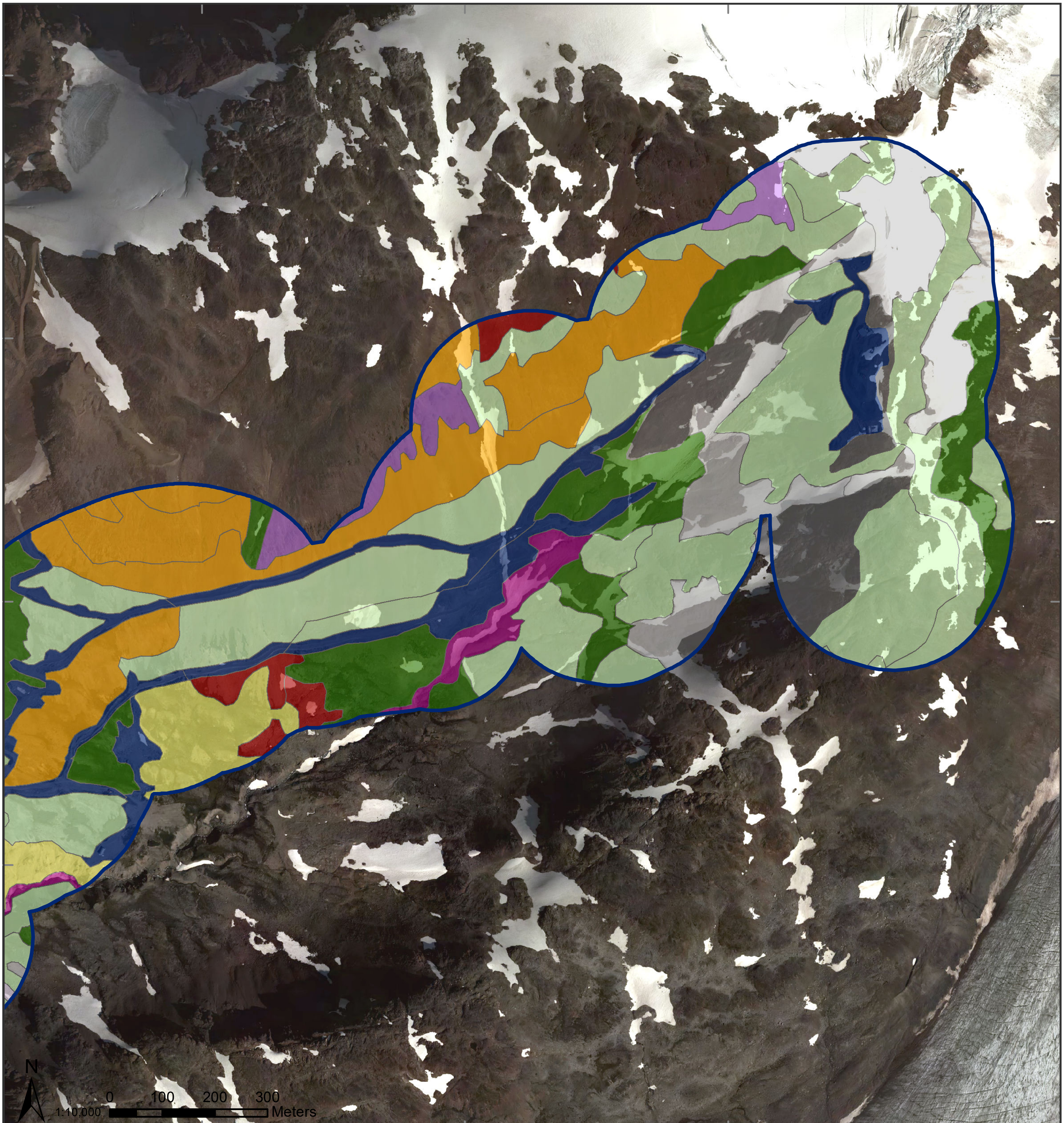
Legend

PFSA

SMU

1a	5	7a	A
1b	5a	7c	I
1c	6	7d	RI
4	6a	8	RO
4a	6b	8a	
4b	6c	8b	
	6d	8c	





Red Mountain Underground Gold Project

Soil Units within the Project Footprint Study Area (Map 5 of 5)

Figure 6.4-1e

Date: 6/6/2017
Map Number: RM-058e
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

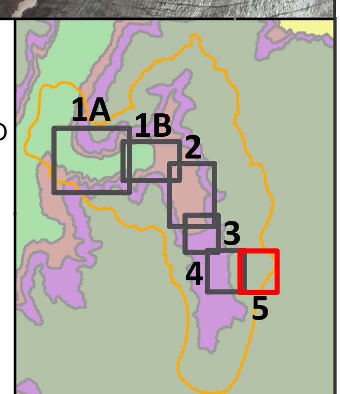
ECOLOGIC environmental consulting

Legend

PFSA

SMU

1a, 1b, 1c, 4, 4a, 4b, 5, 5a, 6, 6a, 6b, 6c, 6d, 7a, 7c, 7d, 8, 8a, 8b, 8c, A, I, RI, RO



). Typical soil classification is variable for this SMU, including O.HFP, O.DYB, GL.DYB, O.EB, GL.EB.

Example of SMU 1a with sandy textures and well developed Ae horizon

Example of nutrient-rich SMU 1b

Plate 6.4-1. SMU 1a and 1b

SMU 1c

SMU 1c soils are mesic, well drained Podzols and Brunisols with a veneer of silt loam at surface of glacial till. They have a surface mineral material that is prone to surface water erosion. Gullying is often evident and they support productive forests.

SMU 4

SUM 4 soils are fine textured and often overlying compact clay-enriched in mineral soils (e.g., SiCL, L, CL) occur in conjunction with gentle sloping glacial till or lacustrine type environments forming in lower/toe to undulating slope positions. They support forests and ecosystems that are slightly more productive than typical in the area. Weak mottling and subsurface compacted soil layers (weak compacted clay pans) are common. Soil gullying and failures are relatively common, particularly on slope gradients from 40% to more than 70%. Soils can include solifluction process in deeper deposits in colder alpine/sub-alpine environments. Common soil subgroups include O.EB, O.DYB, O.MB, BR.GL (weak), GLBR.GL and

GLD.GL. Soils are generally greater than 1 m in depth. These soil types are potentially valuable soil materials for construction of containment facilities or settling ponds.

SMU 4a

SMU 4a soils are derived from moist, fine-textured glacial till (Mb) and glaciolacustrine materials (LG) (often L to SiCL texture) supporting productive forests and often richer ecosystem types depending on position on the landscape. These soils often have moderately-well to imperfectly drained soil materials, variable coarse fragment content, with common seepage but no prominent mottling. They are often found in lower to toe slope positions and near the vicinity of creek draws. Soil Subgroups include GL.MB; O.MB, O.SB. They are potentially unstable soil materials as evidenced by tree buttressing or surface tension fractures, requiring careful management during construction phases. These are good soil types to salvage for construction or reclamation activities requiring finer soil textures and moisture retention, but caution is required owing to high compaction potential, especially during wet periods, as they are subject to degradation while being disturbed.

SMU 4b

SMU 4b are generally dark coloured, fine textured till, colluvium or glaciolacustrine soils that are rich in nutrients, and often contain silt loam textures in the upper 30 cm. They occur most often on moist to wet seepage sites in lower/toe to near level slope positions, as well as alongside creek draws and avalanche tracks. Rooting depth is often greater than 60 cm and most often contain organic-enriched brown to black surface horizons (Ah and Bm horizons) of SiL to SiCL texture and are often underlain by coarser sandy gravelly till or colluvium surficial materials. Soil drainage ranges from well- to imperfectly-drained and with common seepage. SMU4b soils are common to the vicinity of unstable “moving” soil material as evidenced by butressed trees and soil pedoturbation. Soil Subgroups include O.MB, GL.EB (with darker brown colours).

SMU 5

SMU 5 soils occur on flat- to gently undulating glaciofluvial (FG) sand and gravel terraces. They are relatively loose soils with high coarse fragment content (commonly more than 50% of clast volume) with a shallow main rooting zone (often less than 25 cm from surface). Main soil types include bright coloured Humo-Ferric Podzols and Dystric Brunisols (O.HFP, E.DYB, O.DYB). These soils can be moisture- and nutrient-deficient for part of the growing season.

SMU 5a

SMU 5a soils occur on glaciofluvial (FG) material on steeper 30 to 60% slope gradients. They can include hummocky esker type terrain with well to rapid drainage and sandy/gravely soils. Soil depth is usually 30 to 60 cm. Soils often have nutrient poor conditions and are prone to brief periods of summer drought, especially in warm aspects. Rapid debris failures (dry ravelling) are common. Main soil types include bright coloured Podzols and Brunisols (O.HFP, E.DYB, O.DYB).

SMU 6

SMU 6 are shallow soil deposits of colluvium, saprolite (rotten rock) or morainal veneers over bedrock (Plate 6.4-2). Soils often have a high volume (greater than 50%) of coarse fragments and may be derived from decaying bedrock or failures, or thin glacier deposits over bedrock outcrops. They are common on steep slopes (often greater than 50 to 75%). This SMU is common in upper and crest slope position and is moisture shedding. Soil types include acidic Podzols and Brunisols with typical huckleberry/ grouseberry-feathermoss vegetation. Main soil types include O.HFP, E.DYB, O.R, and Non-Soil (NS). Lithic and Shallow Soil Phase are common in forested and alpine areas where bedrock is close to the surface (i.e., less than 50 cm).

Plate 6.4-2. Typical SMU 6 Soil in rocky colluvium

SMU 6b

SMU 6b occurs on moderately deep colluvium (greater than 45 to 60% slope), relatively deep and loose soils with angular coarse fragments. Surficial material depth to bedrock is 50 to 100 cm, and evidence of soil movement is common. Main soil types include O.HFP, EL. DYB and O.DYB. These soils typically have submesic moisture and nutrient regimes (i.e., slightly drier and poorer than typical).

SMU 6c

SMU 6c soils occur on shallow colluvial toes and lower slope positions where soils are moist to wet for the majority of growing season. Soils often dark colours at surface and commonly have seepage but generally contain well-aerated conditions (e.g., devil's club sites). Soil types include GL.MB, GL.EB, and O.EB. These soils are often less than 50 cm to bedrock.

SMU 6d

SMU 6d soils occur on active snow avalanche terrain (and older unstable terrain subject to previous failures) in areas that are subject to failures, flash channel/draw flooding, gullying and continuous seepage. These soils occur at toe of slopes and are subject to wind-shear, blow down events and pedoturbation or soil mixing. Soil types GL.MB, GL.EB, O.RG, O.HG.

SMU 7a

SMU 7a soils occur in alpine and sub-alpine moist meadows that are herb and dwarf shrub-dominated. Brown to black soils are common, occurring in till (Mv/R) and saprolite veneers (Dv/R) over rock. Seepage is common in receiving positions. Soil classification includes O.HFP, O.EB, O.DYB; O.MB, O.SB with Lithic Phases being common (Plate 6.4-3)

SMU 7b

SMU 7b occurs in shrubby fens swamp or marshes in alpine, sub-alpine and forested areas. This is a rare soil and ecosystem type in the PFSA and polygons are very limited in extent (usually less than 0.5 ha). These soil materials form as thin veneers (less than 1 m) of organic material (Ov), mostly derived from saturated conditions (spring flooding is common) and sedge vegetation in depression slope positions. Soils are often less than 30 cm depth to bedrock or compact till/lacustrine. Soils typically would include TE.M and TE.FI. Water table and seepage is usually less than 25 cm from the surface.

SMU 7c

SUM 7c soils (Plate 6.4-3) occur in sedge-dominated wetlands in depression or toe slope position in subalpine, alpine and forested locations. These soils are rare and limited in extent in the PFSA. Expected soil types include moderately decomposed Mesisols (T.M and TY.M). Water table and seepage is usually less than 10 cm from the surface.

SMU 7d

SMU 7d occurs in alpine and subalpine exposed dry alpine tundra with heathers, sparse grasses and lichens, on shallow to broken rock or saprolite (Dvx). SUM 7d contains brown Brunisolic soils with some minor Ah horizons (3 to 10 cm depth). Deeper Ah horizons can occur on long, open slopes greater than 30 to 45% gradient (Plate 6.4-3). SMU 7d is common where solifluction occurs in frozen/thaw environments on moderate to strong slopes (i.e., near to glacier interface). On air photos, these soils with solifluction appear as teardrop/elongate-shaped “blobs” on the smooth landscape. Texture of mineral material is often gravelly fine Sandy Loam (Plate 6.4-3).

Example of E.DYB phase of SMU 7a

Silty deposits over mesic organic material representing SMU 7c

Well-humified example of SMU 7d

Example of SMU 7d with limited humification

Plate 6.4-3. SMU 7a, 7c and 7d

SMU 8

SMU 8 soils occur in moist to wet creek draws and channels where they are subject to annual or semi-annual flooding. These are newly deposited surficial materials often with minimal soil development (Regosols) and are laid down in highly erosive environments often with a finer sand or silt capping over coarser gravel and cobble materials. They occur in creek channels, usually less than 10 m width, in steep mountainous areas.

SMU 8a

SMU 8a soils occur on inactive and older mid- to high-bench fluvial terraces (sgFpt). Soils are often well drained and can be nutrient rich (Plate 6.4-4). Soil types include O.EB, O.MB, GL.R, O.R (in very coarse dry sands). SMU 8 soils can be very sensitive to compaction and water erosion depending on soil texture.

Plate 6.4-4. SMU 8a enriched with organic matter

SMU 8b

SMU 8b (Plate 6.4-5) occurs on active fluvial deposits and floodplains (FAp). Annual flooding is common (e.g., Bitter Creek) and includes some low-bench fluvial and active river deposits with prolonged periods of water inundation. Subsurface seepage is usually present (depth of 20 to 50 cm) for most of year and at the surface in early spring freshet. Most of these soils have high erosion potential, especially where fine sand and silt layers exist at the surface. Common soil types O.R, GL.R, CU.R, GLCU.R.

SMU 8c

SMU 8c soils occur on fluvial fans forming gentle slopes (5 to 26%) and often richer than average. They are potentially subject to annual fluvial sediment input, erosion, and gullying. Subsurface seepage is common and vegetation includes alder and ferns. Common soil types include O.EB, GL.MB. These oils often have high coarse fragment content greater than 50%.

Plate 6.4-5. Typical location for the development of SMU 8b soils, along Bitter Creek.

SMU RO

SMU RO soils occur on bedrock outcrops and are common in upper slope positions and high elevation areas (e.g., alpine). They can include very thin saprolite (Dvx/R) or till veneers (Mvx/R) with less than 10 cm mineral soil material to rock. Soil types include Non-Soil and RO.

SMU I

SMU I contains ice materials at or near the glacier ice where snow often persists late in the growing season in depression slope positions or areas of cold air drainage. Frozen soils and soil-forming processes can exist under or near the ice margins and undergo cryoturbation soil-forming processes such as solifluction.

6.4.2 Soil Salvage Potential in the PFSA

Soil Salvage Potential was assessed for each PFSA bioterrain polygon during the attributing phase of the soil mapping. Table 6.4-2 highlights the SSP categories used. Multiple information sources (including plot data, slope position, ecosystem productivity etc.) were used to assist in estimating the SSP. Combination categories (e.g. L-M, N-VL) were employed in complex or variable SMU polygons.

Table 6.4-2 summarizes the area of each SSP category (Good (G) Moderate-Good (M-G), Moderate (M), Poor (P), Very Poor (VP) and Nil (no potential, such as exposed rock)) within the PFSA. Categories with two classes (e.g. M-G, M-LP or P-N) were also determined in more variable conditions and are listed in the area sums table for SSP. 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.

Table 6.4-2. SSP Categories

SSP	Area (Ha)	Percent
G	210.6	21.9
M-G	56.5	5.9
M	202.1	21.0
M-P	69.6	7.2
P	309.8	32.2
P-N	2.4	0.3
N	109.8	11.4
Total	960.7	100.0

All soil horizons were rated based on available data, which includes morphological and lab data (Section 6.5). 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 more than 17% organic carbon, are often found as thick material (typically greater than 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 biological ‘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). Forest floor materials 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 rarely observed in the field survey (except in isolated occurrences over bedrock outcrops near the Bromley's Humps.

There are 204.6 ha, 52.9 ha and 183.9 ha of G, M-G and M salvage quality soils in the PFSA, respectively, for potential use as salvage material in reclamation in the PFSA (Figures 6.4-2a through 6.4-2e). However, other constraints (steep terrain, limited road access, moisture excess, unstable soils, etc.) in a particular area may limit soil use for salvage.

6.5 LABORATORY SOIL ANALYSIS

Soil results for the analyses can be used to characterize soil development, develop SMUs, and rate suitability for reclamation. The results from Caro Labs in 2016 are presented in Table 6.5-1.

6.5.1 Soil Reaction (pH)

The range of mineral soil pH in the 0 to 15 cm soil layer in the LSA is relatively wide, displaying pH values of 4.8 (extremely acidic) to 8.0 (moderately alkaline). Eleven of the 21 soil samples tested had pH values lower than 5.5. No horizon–specific pH testing was completed.

6.5.2 Free Carbonates

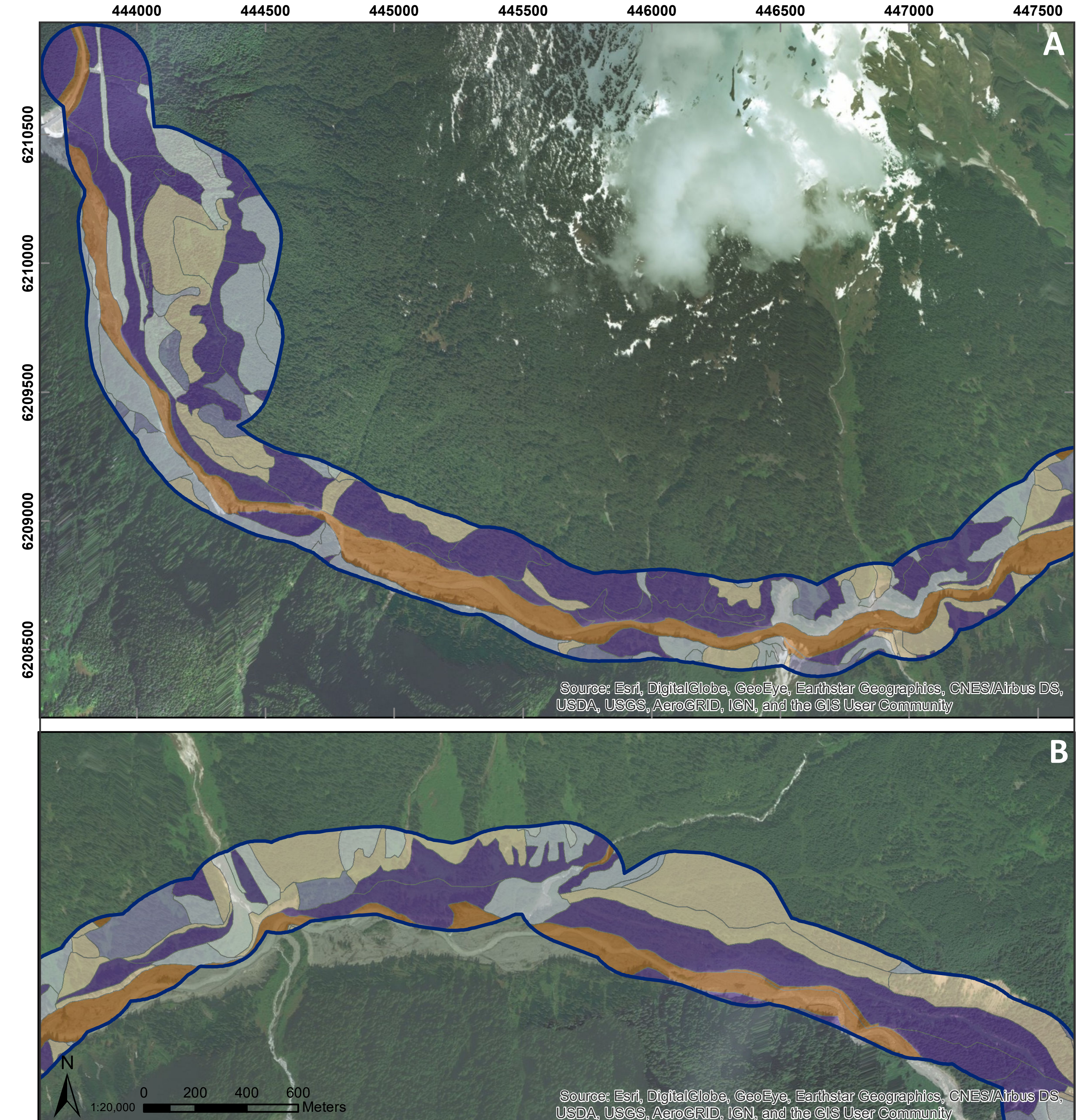
No testing for free carbonates was conducted owing to relatively low pH (4.5 to 6.5) and no visible calcium precipitates were noticed on the soil or coarse fragments in the sample area. Results of lab testing confirm the near total absence of free carbonates samples with a pH of 6.6 or less.

6.5.3 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.

The median value of total carbon content (by combustion) for the 21 samples of 0 to 15 cm surface samples and ranges was 2.0% ranging from 0.2% to 7.7%. Organic wetland soils were not included in this sampling/testing program owing to their sparsity in the PFSA.

The presence of organic matter strongly influences the cation exchange capacity (CEC) of local soils as increasing carbon content shows a positive relationship with increasing CEC. CEC ranged from 0.5 to 7.5 meq/100 g, normal when compared to soils of this general area.



Red Mountain Underground Gold Project

Soil Salvage Potential within the Project Footprint Study Area (Map 1 of 5)

Figure 6.4-2a

Date: 6/6/2017

Map Number: RM-056a

Coordinate System: NAD 1983 UTM Zone 9N

Projection: Transverse Mercator

Datum: North American 1983

IDM MINING

ECOLOGIC

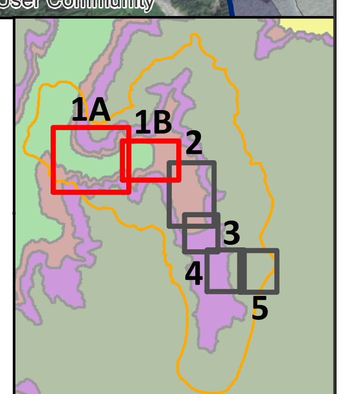
Legend

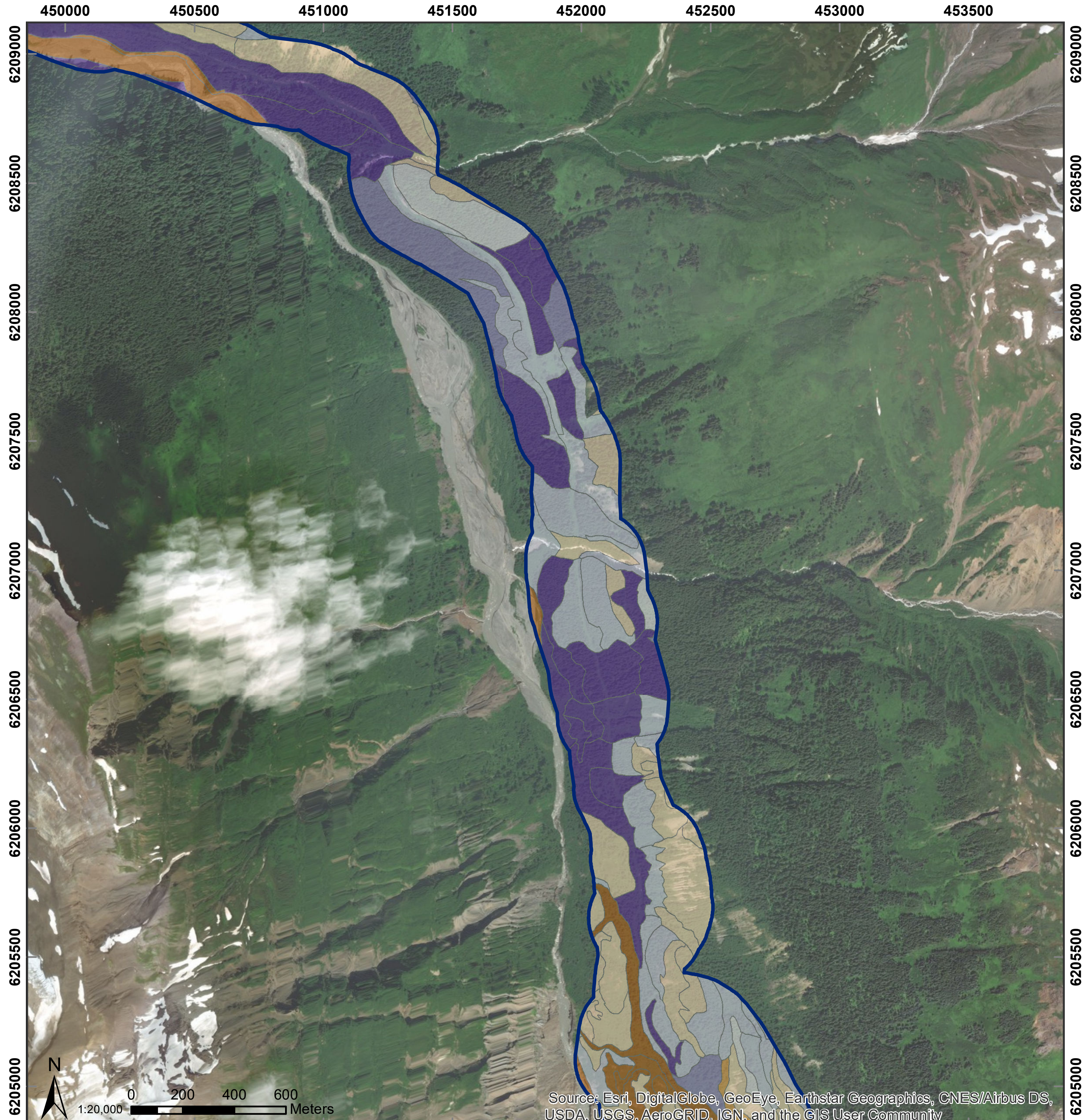
PFSA

Nil (N)

Soil Salvage Potential

- Good (G)
- Moderate to Good (M-G)
- Moderate (M)
- Moderate to Poor (M-P)
- Poor (P)
- Poor to Nil (P-N)





Red Mountain Underground Gold Project

Soil Salvage Potential within the Project Footprint Study Area (Map 2 of 5)

Figure 6.4-2b

Date: 6/6/2017
Map Number: RM-056b
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

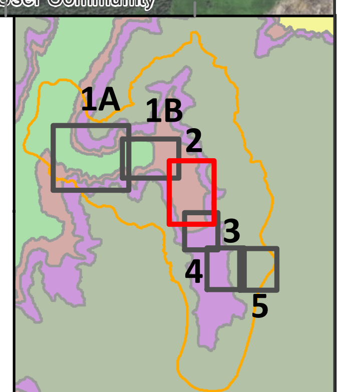
ECOLOGIC environmental consulting

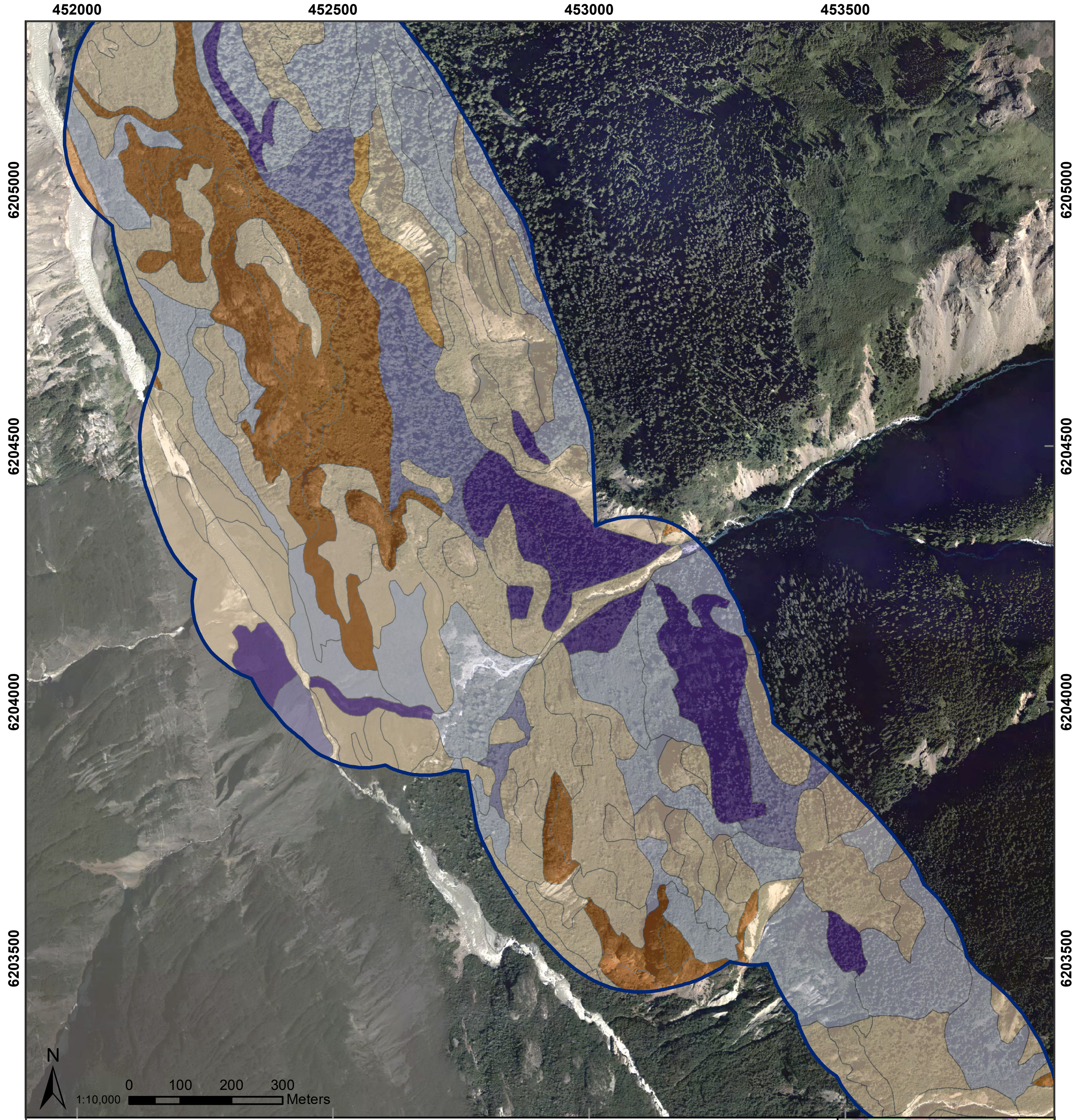
Legend

PFSA

Soil Salvage Potential

- Good (G)
- Moderate to Good (M-G)
- Moderate (M)
- Moderate to Poor (M-P)
- Poor (P)
- Poor to Nil (P-N)
- Nil (N)





Red Mountain Underground Gold Project

Soil Salvage Potential within the Project Footprint Study Area (Map 3 of 5)

Figure 6.4-2c

Date: 6/6/2017
Map Number: RM-056c
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

ECOLOGIC environmental consulting

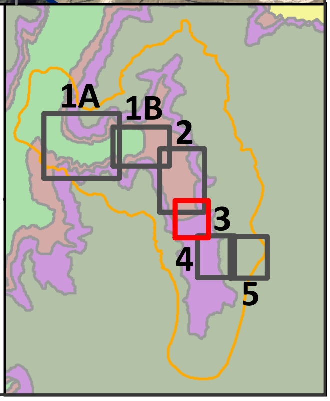
Legend

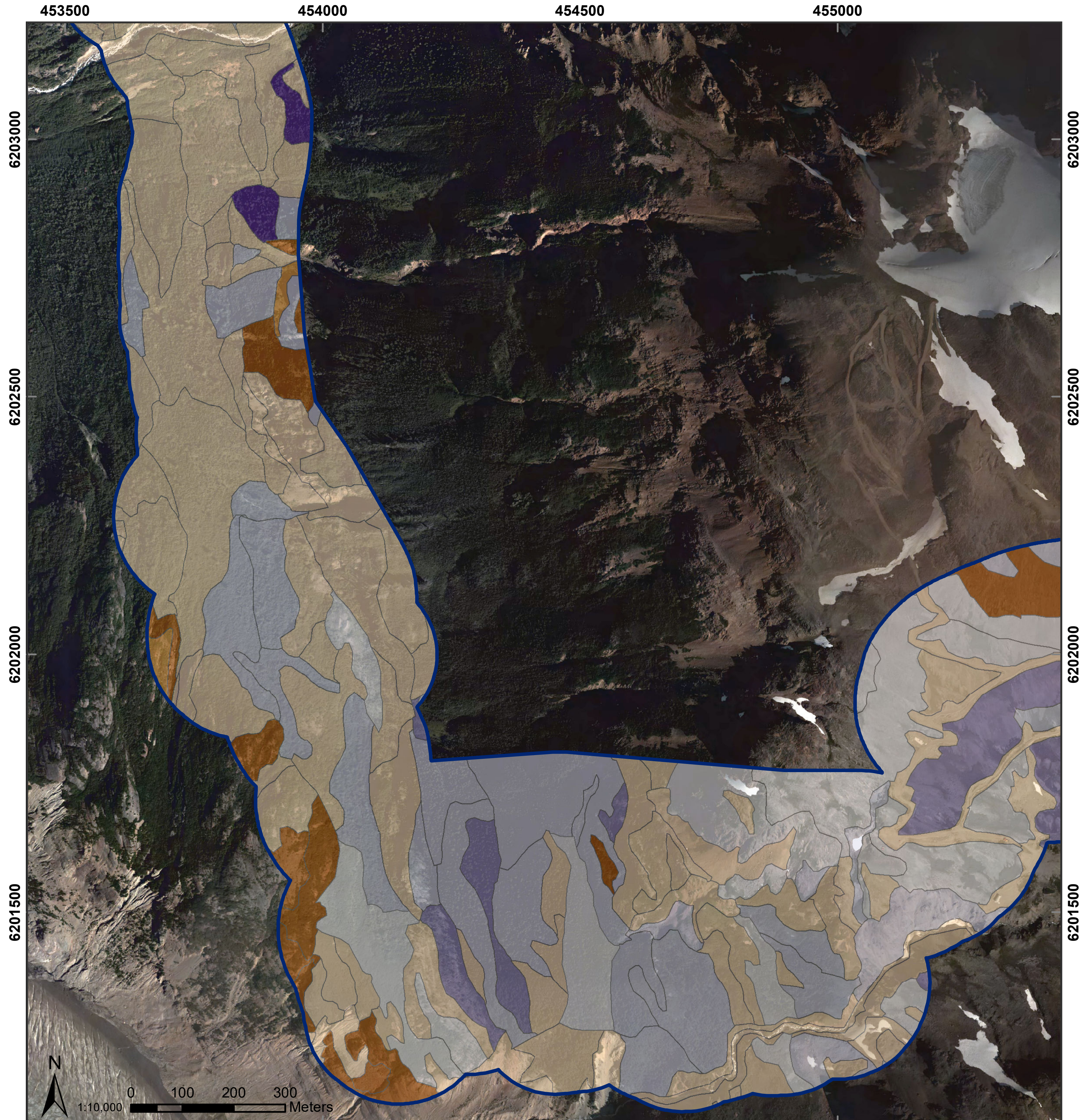
PFSA

Nil (N)

Soil Salvage Potential

- Good (G)
- Moderate to Good (M-G)
- Moderate (M)
- Moderate to Poor (M-P)
- Poor (P)
- Poor to Nil (P-N)





Red Mountain Underground Gold Project

Soil Salvage Potential within the Project Footprint Study Area (Map 4 of 5)

Figure 6.4-2d

Date: 6/6/2017
Map Number: RM-056d
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

IDM MINING

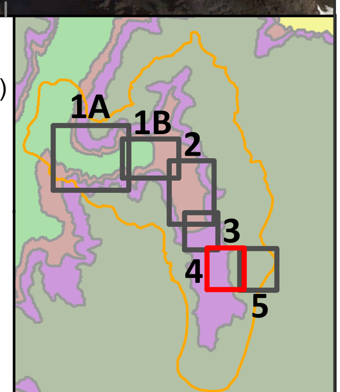
ECOLOGIC environmental consulting

Legend

PFSA

Soil Salvage Potential

- Good (G)
- Moderate to Good (M-G)
- Moderate (M)
- Moderate to Poor (M-P)
- Poor (P)
- Poor to Nil (P-N)
- Nil (N)



Red Mountain Underground Gold Project

Soil Salvage Potential within the Project Footprint Study Area (Map 5 of 5)

Figure 6.4-2e

IDM MINING

ECOLOGIC environmental consulting

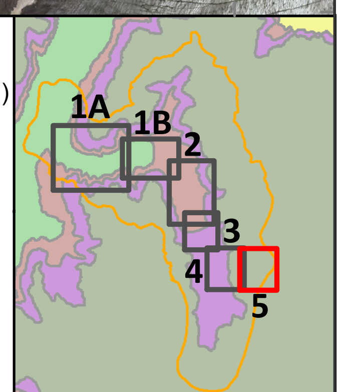
Date: 6/6/2017
Map Number: RM-056e
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

Legend

PFSA

Soil Salvage Potential

- Good (G)
- Moderate to Good (M-G)
- Moderate (M)
- Moderate to Poor (M-P)
- Poor (P)
- Poor to Nil (P-N)
- Nil (N)



6.5.4 Soil Texture

Soil texture is generally assessed in the field by hand texturing. Most field textures indicate soils to be coarse (S, LS) to moderately-coarse (SL, SiL), medium textured (L, SiL) and moderately-fine (SCL,SiCL).

Samples for lab testing were selected for particle size analyses to reflect a range of field textures, from fine to coarse, as found in areas associated with proposed development.

The lab results confirm that soils in the Project area display a range of texture classes from medium to very coarse and mostly key out to SL to L texture class. 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 as moderately low, 8.6%, though it ranges from 1% to 17%C.

6.5.5 Cation Exchange Capacity and Exchangeable Cations

The CEC reflects the soil’s 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, especially near the surface.

Variation in samples included can be viewed by looking at TEM VPRO soil data outputs and results from the 21 particle size, fertility and metal samples:

- surface samples (typically 0 to 15 cm depth — with elevated organic matter ‘humus’ content— 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 4.8 to 8.0).

It is possible the number of “O.DYB” classified for soil pits and identified in VPRO has been overestimated based on the mean pH determine for the 21 samples tested (pH=6.0). The lab results suggest the majority of Brunisols in mid-lower slopes have pH values higher than 5.5 and thus should be classified as Orthic Eutric and Sombric Brunisols with the higher pH values. More acidic upper slope positions or coarse glaciofluvial materials are still expected to be acidic (pH lower than 5.5).

6.5.6 Soil Metals

Caro Labs completed strong acid leachable metal determination in 21 samples from the 0 to 15 cm layer in 2016 in the baseline condition. High values are highlighted for reference. Table 6.5-1 highlights samples which have metal concentrations that exceed acceptable threshold levels under CCME standards. Metal exceedances were found for the following (showing both Client ID and Lab ID; Lab ID is shown in Figure 5.6-1):

- Arsenic, As- all 21 samples submitted;

- Molybdenum, Mo- Plot 10, 11 (13), EL RY1 RW2 (17), RW38 (21);
- Silver, Ag– Plot 32 (11), EL RY1 RW2 (17), RW38 (21), Rm001 (28);
- Selenium, Se- Plot12 (12). RW196 (15), Borrow A (20), EL RY2 (26);
- Copper, Cu- Plot12 (12), OEL Borrow1 (18), RW114 (24), EL RY2 (26), Rm001 (28);
- Nickel, Ni- OEL Borrow1 (18), RW114 (24), RW78 (25); and
- Chromium, Cr- 534RW/RW2 (19), RW78 (25).

Implications of the high baseline metals include possible avoidance of salvaging operations of high metal-containing soils identified above, and to minimize, where possible, introducing elevated metal-containing soils to relatively pristine areas of the PFSA with normal levels of soil metals believed safe for the environment.

The results of the soil metal analysis (Table 6.5-2) indicate eight metals exceed the concentration criteria levels set for the most stringent land use, Agricultural Land Use, at least once:

- Arsenic (all 21 samples, maximum exceedance of 10×);
- Chromium (4 of 21 samples, maximum exceedance of 1.2×);
- Copper (14 of 21 samples, maximum exceedance of 3×);
- Molybdenum (10 of 21 samples, maximum exceedance of 7×);
- Nickel (4 of 21 samples, maximum exceedance of 1.1×);
- Selenium (17 of 21 samples, maximum exceedance 5×);
- Uranium (1 sample, maximum exceedance of slightly above 1×); and
- Zinc (1 sample, maximum exceedance of 1.2×).

Using the less stringent Industrial Land Use criteria (CCME; Table 6.5-3) the list of metals is decreased from eight to three, as follows:

- Arsenic (all samples, maximum exceedance of 10×) – same criteria as per Agricultural Use
- Copper (4 of 21 samples, maximum exceedance of 2.1×)
- Selenium (7 of 21 samples, maximum exceedance 1.6×)

Nine samples exhibit exceedance of industrial criteria for two or more metal species (seven are acidic soils, two are alkaline soils). Arsenic and selenium exceedance occurred across all soil reaction classes (acidic and alkaline). Copper exceedance of Industrial limits was only observed in the acidic soils.

Table 6.5-1. Summary of Soil Reaction and Soil Metal Results and Statistics, Red Mountain Project, 2017

LAB ID	CLIENT SAMPLE ID		SOIL REACTION pH, Saturated Paste		METALS (SALM)							
			pH units	pH-code	Antimony mg/kg dry	Arsenic mg/kg dry	Barium mg/kg dry	Beryllium mg/kg dry	Cadmium mg/kg dry	Chromium mg/kg dry	Cobalt mg/kg dry	Copper mg/kg dry
		Detection:	0.1		0.1	0.4	1	0.1	0.04	1	0.1	0.2
7011325-08	001 0-15 cm (soil)		**5.0**	**2**	3.2	59.4	91	0.6	0.42	21.6	11.2	85.9
7011325-09	V24 0-15 (soil)		**5.0**	**2**	7.4	36.1	70	0.9	0.17	8.3	20.1	90
7011325-10	30 0-15 (soil)		**4.8**	**2**	4.2	30	79	0.4	0.16	22.8	23.2	104
7011325-11	FS882 Plot 32 0-15 (soil)		**5.5**	**3**	5.6	32.2	181	0.5	1.36	16.8	17.3	86
7011325-12	012 0-15 (soil)		**5.2**	**3**	1.8	22.3	126	0.5	1.13	20	14.6	26.2
7011325-13	011 0-15 (soil)		**5.0**	**2**	4	73.6	54	0.3	0.45	29	13.3	194
7011325-14	V21 0-15 (soil)		**5.0**	**2**	3	25	114	0.5	0.36	30.6	17.9	85.2
7011325-15	RW 196 (soil)		**5.0**	**2**	2.1	28.5	107	0.4	0.5	25.7	12.5	66.1
7011325-16	EL RY 3RW2 (soil)		**5.1**	**3**	3.4	42.5	65	0.2	0.45	16.8	7.7	69.6
7011325-17	EL RY1 RW2 (soil)		**5.6**	**4**	1.5	21.5	316	0.2	0.62	13.6	10.9	107
7011325-18	OEL Borrow 1 (soil)		**8.0**	**8**	1.9	20.8	157	0.3	0.78	79.2	15.4	56.6
7011325-19	534 RW/RW2 (soil)		**7.6**	**7**	2.3	16.3	90	0.3	0.64	67.2	10.7	59.7
7011325-20	Borrow A (soil)		**5.7**	**4**	1.8	14	247	0.6	0.38	33.3	18.5	72
7011325-21	RW 38 (soil)		**4.9**	**2**	4.7	60	141	0.2	0.68	21.3	9.8	99.1
7011325-22	KL113 (soil)		**7.4**	**7**	2.6	124	176	0.4	0.86	22.4	13.5	69.9
7011325-23	Radio EL 5 RW2		**5.3**	**3**	3.8	23.9	87	0.5	0.43	18	15.2	79.3
7011325-24	RW 114 (soil)		**7.8**	**7**	2.6	24	91	0.3	1.02	55.3	12.7	60.4
7011325-25	RW 78 (soil)		**8.0**	**8**	2	19.8	142	0.4	0.78	75.9	15.6	68.3
7011325-26	EL RY2 (soil)		**7.8**	**7**	2.5	16	300	0.5	0.56	25.9	15.6	61.9
7011325-27	RW 92 (soil)		**7.3**	**6**	2.4	19.9	89	0.3	0.81	67.6	14.1	61.3
7011325-28	Rm 001 0-15 (soil)		**5.9**	**4**	2.5	21.3	55	0.3	0.16	28.3	7.9	51.6
STATISTICS	COUNT		21		21	21	21	21	21	21	21	21
	MAX		8.0		7.4	124	316	0.9	1.36	79.2	23.2	194.0
	MIN		4.8		1.5	14	54	0.2	0.16	8.3	7.7	26.2
	MEDIAN		5.5		2.6	24	107	0.4	0.56	25.7	14.1	69.9
	AVERAGE		6.0		3.1	35	132	0.4	0.61	33.3	14.2	78.8
	PERCENTILE_80%		7.6		4.0	43	176	0.5	0.81	55.3	17.3	90
	Ratio: MAX/Min				5	9	6	5	9	10	3	7
	Ratio: MAX/AGRIC_Crit.Min				37%	1033%	42%	36%	97%	124%	58%	308%
	Parameter:		**pH**		**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**
	Criteria-AGRI_Land_Use:	mg/kg dry	na		20	12	750	2.5	1.4	64	40	63
Note:	color code		**5.3**	Acidic								
			7.8	Basic								

Table 6.5-1. Summary of Soil Reaction and Soil Metal Results and Statistics, Red Mountain Project, 2017

CLIENT SAMPLE ID	Lead mg/kg dry	Mercury mg/kg dry	Molybdenum mg/kg dry	Nickel mg/kg dry	Selenium mg/kg dry	Silver mg/kg dry	Thallium mg/kg dry	Tin mg/kg dry	Uranium mg/kg dry	Vanadium mg/kg dry	Zinc mg/kg dry
	0.2	0.04	0.1	0.4	0.5	0.2	0.1	0.2	0.05	0.4	2
001 0-15 cm (soil)	23	0.07	9.6	18	2.2	0.5	0.2	0.7	0.74	78.9	120
V24 0-15 (soil)	16.4	0.05	9.5	31.8	1.4	0.1	0.3	0.2	0.44	33.3	36
30 0-15 (soil)	34.3	0.08	12.5	36.9	1.8	0.4	0.4	0.5	0.51	81.8	48
FS882 Plot 32 0-15 (soil)	42.7	0.05	7	43.8	2.2	1	0.2	0.1	0.53	45.1	132
012 0-15 (soil)	42.4	0.08	1.3	15	0.25	0.1	0.3	0.3	0.49	65	242
011 0-15 (soil)	22.5	0.02	32.6	30.3	3.2	0.5	0.05	0.3	1.18	99.3	138
V21 0-15 (soil)	11.8	0.06	4.7	50.4	3	0.1	0.1	0.3	0.32	70.8	93
RW 196 (soil)	17	0.07	2.7	21.4	0.9	0.7	0.1	0.2	0.77	67.8	85
EL RY 3RW2 (soil)	15.4	0.02	12	17.4	3.9	0.6	0.05	0.1	1.06	70	90
EL RY1 RW2 (soil)	9.6	0.02	27.2	15.3	2.7	0.5	0.05	0.1	0.6	68.7	102
OEL Borrow 1 (soil)	12.8	0.02	2.1	50.1	1.2	0.5	0.05	0.3	1.22	74.5	89
534 RW/RW2 (soil)	8.7	0.02	5	39.8	1.8	0.5	0.05	0.1	0.46	60.3	74
Borrow A (soil)	16.8	0.07	1.8	18.8	0.25	0.4	0.1	0.3	0.39	95.9	82
RW 38 (soil)	28.5	0.04	15.4	22.2	4.7	1	0.1	0.3	1.92	89.2	114
KL113 (soil)	18.8	0.02	2.2	30.2	2.4	0.6	0.2	0.2	0.5	61	96
Radio EL 5 RW2	26.1	0.06	3.9	39	1.8	0.6	0.1	0.1	0.38	46.9	86
RW 114 (soil)	12.5	0.04	5.4	46	3.1	0.7	0.1	0.1	0.56	59.9	98
RW 78 (soil)	10.2	0.02	4.9	55.4	1.7	0.5	0.05	0.3	0.55	83.4	83
EL RY2 (soil)	22	0.02	1.6	25.8	0.6	0.4	0.1	0.1	0.36	79.5	84
RW 92 (soil)	11.8	0.05	4.5	53.5	2.9	0.8	0.1	0.1	0.56	65.5	85
Rm 001 0-15 (soil)	12.1	0.05	4.2	26.1	3	1.1	0.1	0.3	0.32	65.4	55
COUNT	21	21	21	21	21	21	21	21	21	21	21
MAX	42.7	0.08	32.6	55.4	4.7	1.10	0.40	0.7	1.92	99.3	242
MIN	8.7	0.02	1.3	15.0	0.3	0.10	0.05	0.1	0.32	33.3	36
MEDIAN	16.8	0.05	4.9	30.3	2.2	0.50	0.10	0.2	0.53	68.7	89
AVERAGE	19.78	0.04	8.1	32.7	2.1	0.55	0.13	0.2	0.66	69.6	97
PERCENTILE_80%	26.1	0.07	12	46.0	3.0	0.70	0.20	0.3	0.77	81.8	114
Ratio: MAX/Min	5	4	25	4	19	11	8	7	6	3	7
Ratio: MAX/AGRIC_Crit.Min	61%	1%	652%	111%	470%	6%	40%	35%	101%	76%	121%
Parameter:	**Lead**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**Tin**	**Uranium**	**Vanadium**	**Zinc**
Criteria-AGRI_Land_Use:	70	6.6	5	50	1	20	1	2	1.9	130	200
color code											

Table 6.5-2. Summary of Agriculture Land Use Soil Metal Concentration Criteria Compliance, Red Mountain

Client Sample ID	pH units 0.1	pH-code AGRICULTURAL			Antimony 20	Arsenic 12	Barium 750	Beryllium 2.5	Boron 2	Cadmium 1.4	Chromium 64	Cobalt 40	Copper 63
RW 38 (soil)	**4.9**	**2**	1	14	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
001 0-15 cm (soil)	**5.0**	**2**	1	1	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
V24 0-15 (soil)	**5.0**	**2**	1	2	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
30 0-15 (soil)	**4.8**	**2**	1	3	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
FS882 Plot 32 0-15 (soil)	**5.5**	**3**	1	4	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
011 0-15 (soil)	**5.0**	**2**	1	6	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
V21 0-15 (soil)	**5.0**	**2**	1	7	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
EL RY 3RW2 (soil)	**5.1**	**3**	1	9	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
EL RY1 RW2 (soil)	**5.6**	**4**	1	10	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
Radio EL 5 RW2	**5.3**	**3**	1	16	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
RW 196 (soil)	**5.0**	**2**	1	8	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
Rm 001 0-15 (soil)	**5.9**	**4**	1	21	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
012 0-15 (soil)	**5.2**	**3**	1	5	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Borrow A (soil)	**5.7**	**4**	1	13	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
RW 78 (soil)	**8.0**	**8**	2	18	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
OEL Borrow 1 (soil)	**8.0**	**8**	2	11	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
534 RW/RW2 (soil)	**7.6**	**7**	2	12	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
RW 92 (soil)	**7.3**	**6**	2	20	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
KL113 (soil)	**7.4**	**7**	2	15	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
RW 114 (soil)	**7.8**	**7**	2	17	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
EL RY2 (soil)	**7.8**	**7**	2	19	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
SUM of 'False' ratings					0	21	0	0	0	0	4	0	14

Table 6.5-2. Summary of Agriculture Land Use Soil Metal Concentration Criteria Compliance, Red Mountain

Client Sample ID	Lead 70	Mercury 6.6	Molybdenum 5	Nickel 50	Selenium 1	Silver 20	Thallium 1	tin 2	Uranium 1.9	Vanadium 130	Zinc 200	Count of EXCEED
RW 38 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	5
001 0-15 cm (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
V24 0-15 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
30 0-15 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
FS882 Plot 32 0-15 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
011 0-15 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
V21 0-15 (soil)	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
EL RY 3RW2 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
EL RY1 RW2 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
Radio EL 5 RW2	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	3
RW 196 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
Rm 001 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
012 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	2
Borrow A (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
RW 78 (soil)	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	5
OEL Borrow 1 (soil)	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
534 RW/RW2 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
RW 92 (soil)	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	4
KL113 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	3
RW 114 (soil)	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	3
EL RY2 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
SUM of 'False' ratings	0	0	10	4	17	0	0	0	1	0	1	

Table 6.5-3. Summary of Industrial Land Use Soil Metal Concentration Criteria Compliance, Red Mountain Project 2017

Client Sample ID	pH units	pH-code			Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper
	0.1	INDUSTRIAL			20	12	2000	8	2	22	87	300	91
011 0-15 (soil)	**5.0**	**2**	1	6	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
RW 38 (soil)	**4.9**	**2**	1	14	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
30 0-15 (soil)	**4.8**	**2**	1	3	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
EL RY 3RW2 (soil)	**5.1**	**3**	1	9	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
EL RY1 RW2 (soil)	**5.6**	**4**	1	10	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
Rm 001 0-15 (soil)	**5.9**	**4**	1	21	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
001 0-15 cm (soil)	**5.0**	**2**	1	1	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
V24 0-15 (soil)	**5.0**	**2**	1	2	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
V21 0-15 (soil)	**5.0**	**2**	1	7	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
RW 196 (soil)	**5.0**	**2**	1	8	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
FS882 Plot 32 0-15 (soil)	**5.5**	**3**	1	4	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
012 0-15 (soil)	**5.2**	**3**	1	5	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Radio EL 5 RW2	**5.3**	**3**	1	16	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Borrow A (soil)	**5.7**	**4**	1	13	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
RW 92 (soil)	**7.3**	**6**	2	20	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
RW 114 (soil)	**7.8**	**7**	2	17	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
534 RW/RW2 (soil)	**7.6**	**7**	2	12	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
KL113 (soil)	**7.4**	**7**	2	15	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
EL RY2 (soil)	**7.8**	**7**	2	19	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
OEL Borrow 1 (soil)	**8.0**	**8**	2	11	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
RW 78 (soil)	**8.0**	**8**	2	18	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
SUM of 'False' ratings					0	21	0	0	0	0	0	0	4

Table 6.5-3. Summary of Industrial Land Use Soil Metal Concentration Criteria Compliance, Red Mountain Project 2017

Client Sample ID	Lead 600	Mercury 50	Molybdenum 40	Nickel 89	Selenium 2.9	Silver 40	Thallium 1	Tin 300	Uranium 300	Vanadium 130	Zinc 360	Count of EXCEED
011 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	3
RW 38 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	3
30 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
EL RY 3RW2 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
EL RY1 RW2 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
Rm 001 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
001 0-15 cm (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
V24 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
V21 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
RW 196 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
FS882 Plot 32 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
012 0-15 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
Radio EL 5 RW2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
Borrow A (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
RW 92 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
RW 114 (soil)	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	2
534 RW/RW2 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
KL113 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
EL RY2 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
OEL Borrow 1 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
RW 78 (soil)	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	1
SUM of 'False' ratings	0	0	0	0	7	0	0	0	0	0	0	

Elevated soil metal species appear generally similar to those noted for local geologic materials (waste rock, ore, and talus) as determined for static testing as part of ML/ARD investigations (SRK 2017). The key preliminary static testing findings, where metal enrichment is described by SRK as species that are found in concentrations that exceed ten times their average crustal abundance, include:

- Elevated element concentrations of As and Cu are found across all 13 rock units, ore and waste rock units, as described by SRK (Hillside Porphyry 'HIp' and fragmented 'xHIp'; Mudstone interbedded 'MSI', Tuffs, bedded volcanoclastic 'TfB', Tuffs, fragmented volcanoclastic 'xTF', Contact breccias 'xTF-TfB', Fault Zone 'FZ', unknown/composite lithology 'N/A'and Talus 'N/A'.
- Elevated Se concentrations are common to 8 of the 13 rock units (i.e., not in xHIp-ore/waste rock, MSI, xTF-TfB, FZ).

Other soil metals species of concern at more stringent criteria:

- Elevated soil Mo was often associated with elevated soil Cu, but, unlike Cu, is found in excess of 10× crustal concentrations in only 3 of the rock units (xTF ore/waste, and Talus).
- Elevated soil Cr, Ni are often found together, and at relatively low levels; they are similarly companions in some rock units (5 of 13 units), though Cr is more common (9 of 13 rock units).
- Soil uranium concentration was found to be at criteria levels in only one soil sample (RW38) and similarly rare in rock units ('xTF waste rock only).
- Soil zinc concentration was found to be slightly elevated in only one soil sample (O12) and relatively common across rock units (10 of 13).
- Silver was indicated to be high in all rock units but below the most stringent critical soil concentrations in all soil samples.

The results of soil metal analysis provide an indication of the metal species of concern for the Project. There were no samples from deep, un-weathered (non-bedrock) soil parent materials evaluated as part of the soil metal or ML/ARD programs. These materials may or may not be absent from the site where deep excavations or where other direct project disturbances are anticipated. Thick overburden, if present, will be described in local geotechnical investigation programs.

6.6 Plants of Conservation Interest

A total of 48 occurrences of 42 rare species were recorded during the rare plant surveys including 8 vascular plant, 19 lichen, and 15 moss and liverwort species (Table 6.6-1). Of these 42 species, 35 are listed by the BC CDC consisting of 3 vascular plant, 18 lichen, and 14 moss and liverwort species (Tables 6.6-2 to 6.6-4; Figures 6.6-1 to 6.6-3). None of the species are listed under SARA or by COSEWIC. The remaining seven species (five vascular plants, one lichen, and one moss) are previously undescribed, newly discovered, or not previously known to occur in British Columbia or North America. Appendix J contains a complete list of plants and lichens identified in the Project and Appendix K contains detailed information of the rare species occurrences (e.g., location, site information).

Table 6.6-1. Summary of Rare Plants and Lichen Identified within the LSA

Conservation Rank	Vascular Plants	Lichen	Mosses and Liverworts
S1 (Red-listed)	0	5	2
S1S2 (Red-listed)	0	0	2
S1S3 (Red-listed)	1	0	0
S2 (Red-listed)	0	2	2
S2? (Red-listed)	0	1	0
S2S3 (Blue-listed)	1	3	2
S3 (Blue-listed)	1	6	6
S3? (Blue-listed)	0	1	0
SARA	0	0	0
Non-Listed Rare Species[1]	5	1	1
Total	**8**	**19**	**15**

[1]*Includes species that are newly discovered, previously undescribed, or undocumented in British Columbia*

Table 6.6-2. Rare Vascular Plants Observed within the LSA

Vascular Plant Species	Common Name	Provincial Conservation Status	BC List Status	Global Conservation Status
Anemone narcissiflora var. *vilocissima*	Narcissus-flowered anemone	S1S3	Red	G5T4
Botrychium crenulatum	Scalloped moonwort	S2S3	Blue	G3
Botrychium spathulatum	Spatulate moonwort	S3	Blue	G3
Micranthes separate		An undescribed species that appears to be rare, limited to the BC Coast Ranges, known from < 10 sites		
Taraxacum amarum		Previously undocumented species, not represented among any previous herbarium specimens, hence likely to be rare		
Taraxacum sp. *nov.* (short)		Previously undocumented species, not represented among any previous herbarium specimens, hence likely to be rare		
Taraxacum sp. *nov.* (tall)		Previously undocumented species, not represented among any previous herbarium specimens, hence likely to be rare		
Taraxacum speculorum		Previously undocumented species, not represented among any previous herbarium specimens, hence likely to be rare		

Table 6.6-3. Rare Lichens Observed within the LSA

Lichen Species	Common Name	Provincial Conservation Status	BC List Status	Global Conservation Status
Baeomyces carneus	Florke Scale Beret Lichen	S1	Red	GNR
Bryoria nitidula	Horsehair lichen	S2S3	Blue	G5
Cetraria nigricans	Blackened Iceland lichen	S3	Blue	G5
Cladonia coccifera	Madame Pixie Lichen	S1	Red	G5
Cladonia macrophylla	Fig-leaved Pixie Lichen	S2	Red	GNR
Cladonia pseudalcicornis	Big-foot lichen	S2S3	Blue	GNR
Collema ceraniscum	Pincushion Tarpaper Lichen	S1	Red	GNR
Collema crispum	Crinkled Pulp Lichen	S1	Red	GNR
Fuscopannaria ahlneri	Corrugated Shingles Lichen	S2S3	Blue	G4G5
Heterodermia unknown sp.		A species not previously noted from North America		
Leptogidium dendriscum		S3	Blue	G3G5
Leptogium tenuissimum	Birdnest Jellyskin Lichen	S2?	Red	GNR
Lobaria oregana	Lettuce lichen	S3	Blue	G4G5
Lobaria retigera	Smoker's Lung Lichen	S3	Blue	GNR
Nephroma isidiosum	Peppered Kidney Lichen	S3	Blue	G3G5
Placynthium asperellum	Lilliput Ink Lichen	S3?	Blue	G4G5
Santessoniella arctophila	Arctic Dust Bunnies Lichen	S1	Red	GNR
Stereocaulon botryosum	Cauliflower Foam Lichen	S2	Red	G4
Umbilicaria lambii	Windward Rocktripe Lichen	S3	Blue	G2G4

Table 6.6-4. Rare Moss and Liverwort Species Observed within the LSA

Moss or Liverwort Species	Common Name	Provincial Conservation Status	BC List Status	Global Conservation Status
Cinclidium stygium	Sooty Cupola Moss	S3	Blue	G5
Grimmia atrata	Grimmia Dry Rock Moss	New discovery for BC, known to be a rare species elsewhere		G5?
Grimmia donniana	Donn's Grimmia Moss	S2S3	Blue	G4G5
Imbribryum gemmiparum	Bud-tipped Bryum	S2S3	Blue	G3G5
Mielichhoferia elongata	Mielichhofer's Copper Moss	S1S2	Red	G4TNR
Mielichhoferia mielichhoferiana		S2	Red	G4T2T3
Nardia compressa	Compressed Flapwort	S3	Blue	G4G5
Niphotrichum pygmaeum	Pygmy Racomitrium Moss	S3	Blue	GU
Peltolepis quadrata		S2	Red	G4

Moss or Liverwort Species	Common Name	Provincial Conservation Status	BC List Status	Global Conservation Status
Pohlia cardotii	Cardot's Nodding Moss	S3	Blue	G2G3
Pohlia erecta	Erect Nodding Moss	S1	Red	G3G5
Pohlia pacifica	Pacific pohlia moss	S1S2	Red	GU
Ptychostomum inclinatum		S3	Blue	G5?
Sauteria alpina	Snow Lungwort	S3	Blue	G4?
Schistidium venetum	Bluish Bloom Moss	S1	Red	GNR

Several species are considered rare world-wide based on NatureServe (NatureServe 2015), though none are listed as rare under SARA. Two vascular plant species are considered vulnerable, *Botrychium crenulatum* and *Botrychium spathulatum,* with a global ranking of G3. Two lichen species are considered vulnerable in some areas, *Leptogidium dendriscum* and *Nephroma isidiosum*, with a global ranking of G3G5 while one lichen species observed during the rare plant surveys, *Umbilicaria lambii*, is considered imperiled in some areas with a global ranking of G2G4. Two moss species (*Imbribryum gemmiparum* and *Pohlia erecta*) have a global ranking of G3G5 and thus are considered vulnerable globally. One additional moss species (*Pohlia cardotii*) has a ranking of G2G3 and is therefore considered imperiled. However, global classification of North American species is not yet complete. Some species detected in the rare plant survey with a global rank of GU or GNR may therefore be of a high conservation priority.

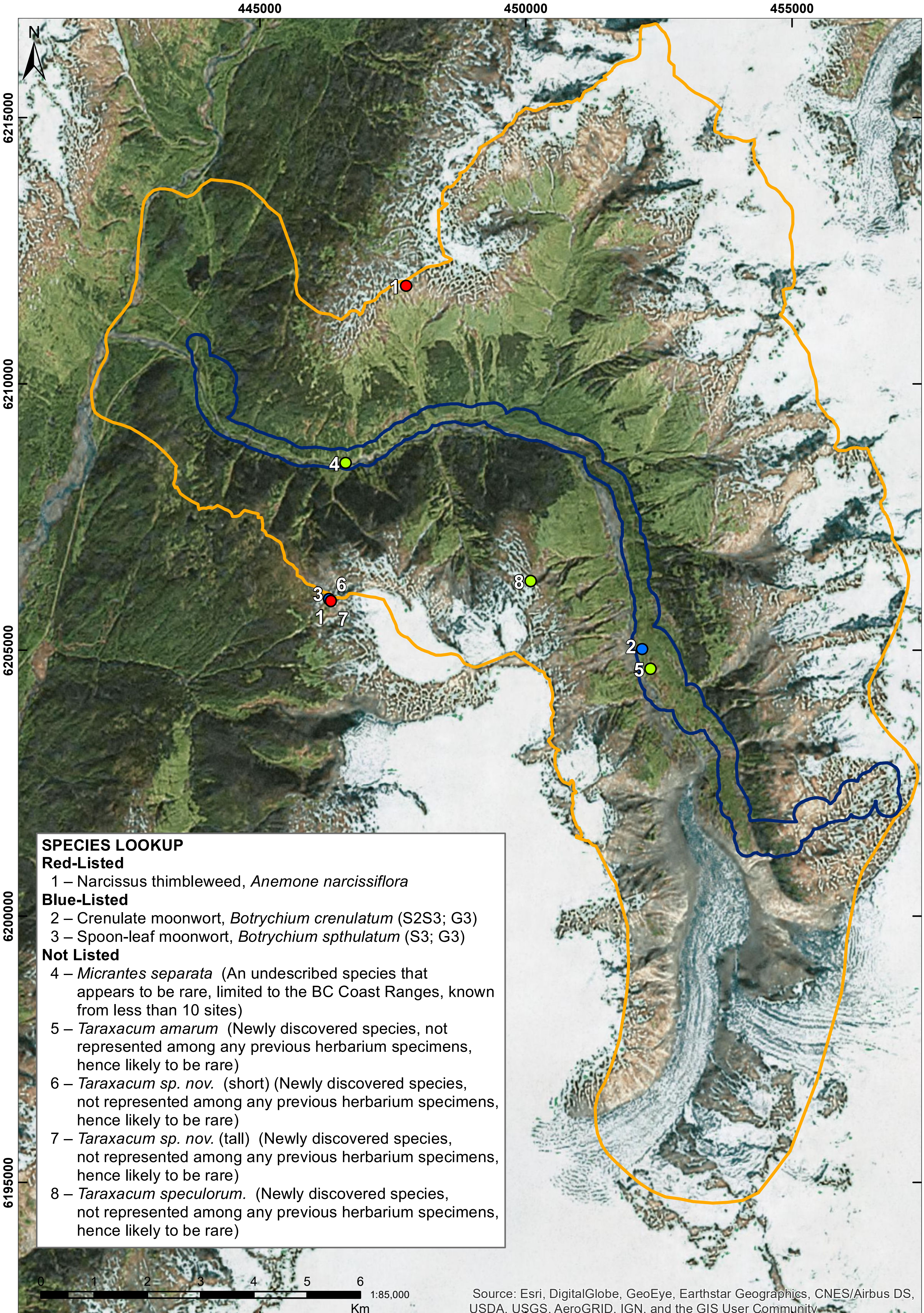
6.7 Invasive Plant Species

The floristic list compiled during the 2016 field studies was reviewed to identify non-native (i.e., potentially invasive) species and determine if any are listed as provincially noxious or invasive (Table 6.7-1). One genus (*Actium* sp.) is considered to be noxious under the *Weed Control Act*. None of the exotic species observed are NWIPC priority species for management.

Table 6.7-1. Non-native Species Identified during the 2016 surveys

Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name	Common Name
Actium sp.[1]	burdock	*Mycelis muralis*	wall lettuce	*Taraxacum aurulosum*	NA
Agrostis gigantea	redtop	*Plantago major*	common plantain	*Taraxacum retroflexum*	reflexed-lobed dandelion
Dactylis glomerata	orchard grass	*Poa annua*	annual bluegrass	*Taraxacum scanicum*	rock dandelion
Galeopsis bifida	split-lip hemp-nettle	*Ranunculus repens*	creeping buttercup	*Trifolium repens*	white clover

[1]*rated as 'Noxious' by the Weed Control Act*



Red Mountain Underground Gold Project

Occurrences of Rare Vascular Plants within the Local Study Area

Figure 6.6-1

ECOLOGIC environmental consulting

IDM MINING

Date: 6/1/2017
Map Number: RM-017
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

Legend

Local Study

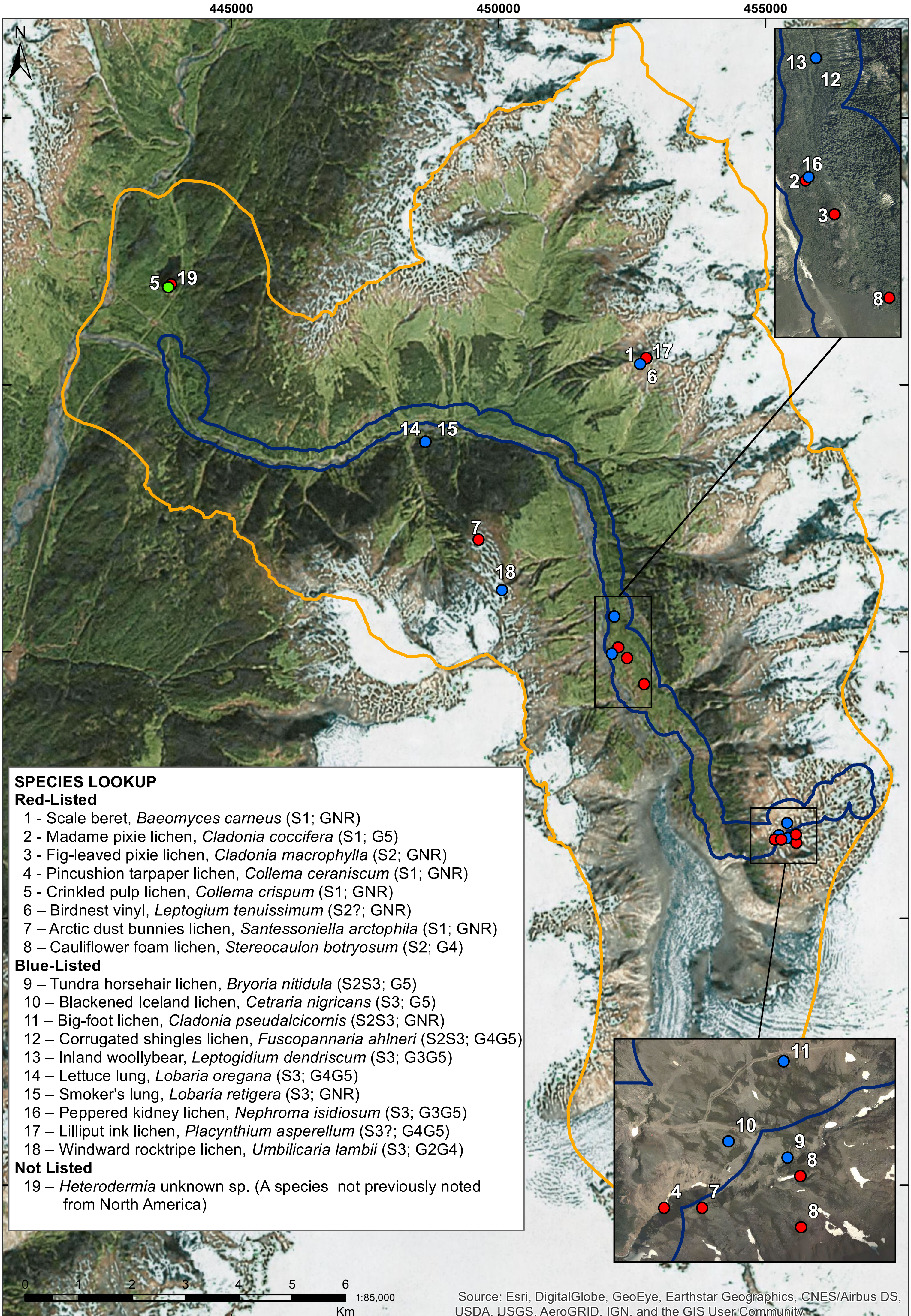
Project Footprint Study Area

BC CDC Rank

Red-Listed

Blue-Listed

Not Listed



Red Mountain Underground Gold Project

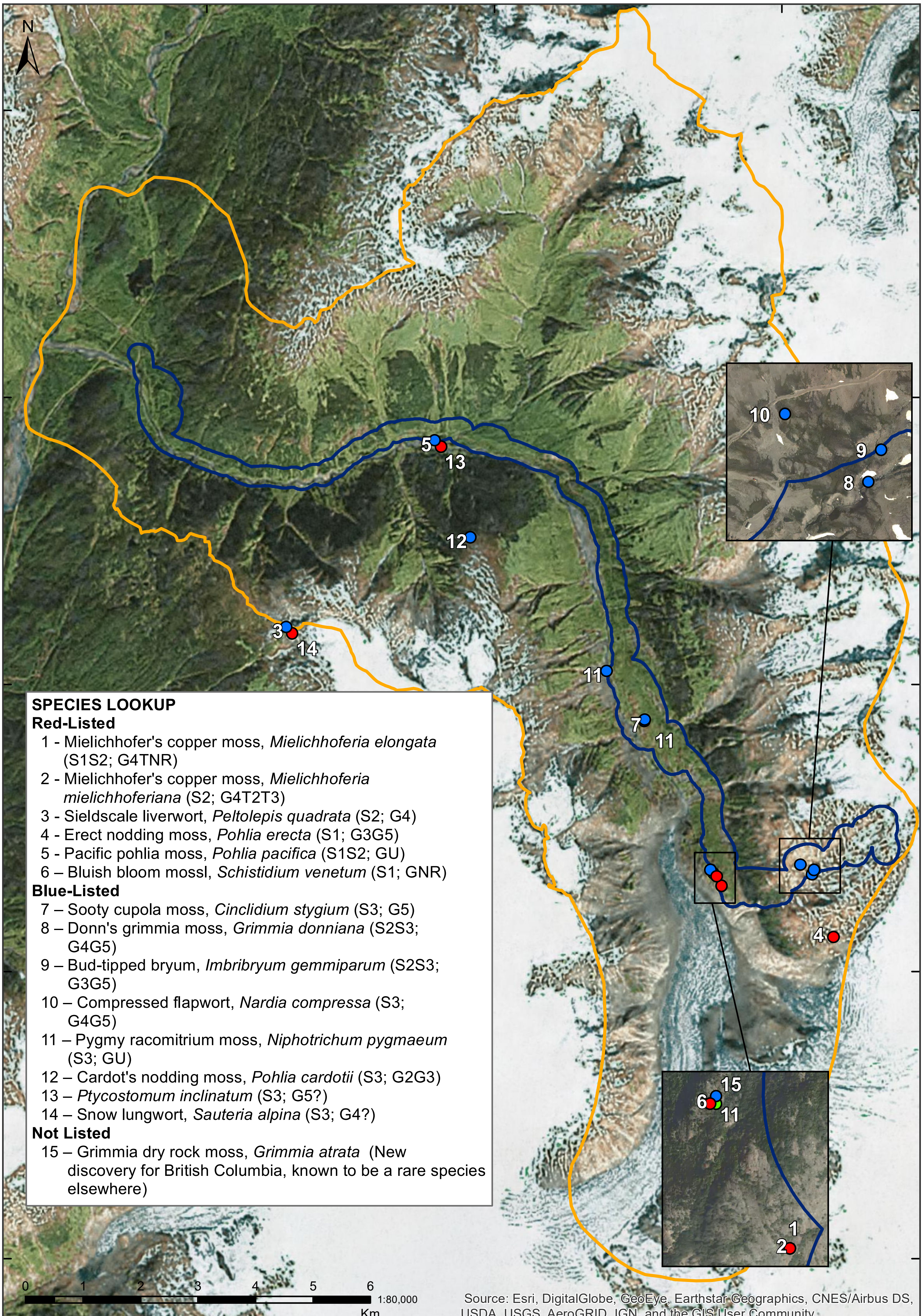
Occurrences of Rare Lichen within the Local Study Area

Figure 6.6-2

ECOLOGIC environmental consulting

IDM MINING

Date: 6/1/2017
Map Number: RM-018
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983



Red Mountain Underground Gold Project

Occurrences of Rare Bryophytes within the Local Study Area

Figure 6.6-3

ECOLOGIC environmental consulting

IDM MINING

Date: 6/1/2017
Map Number: RM-019
Coordinate System: NAD 1983 UTM Zone 9N
Projection: Transverse Mercator
Datum: North American 1983

Legend

- Local Study Area
- Project Footprint Study Area

BC CDC Rank

- Red-Listed
- Blue-Listed
- Not Listed

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APPENDIX A. SUMMARY OF ECOSYSTEM FIELD SAMPLE DATA

Appendix A. Summary of Ecosystem Field Sample Data - RSA

Date	Plot	Surveyors	Elevation	X	Y	BGC	Site_Serie	SMR	SNR	Mesoslope	Floodplain	Structural	Success_St	Canopy_Com	Drainage
7/9/2016	14	RD	491	474569	6208548	ICHvc	Wf01	8	C	Level	No	2b			
7/9/2016	15	RD	487	474555	6208545	ICHvc	Ws00	6	D	Level	Floodplain	3b			M
7/9/2016	16	RD	1232	473033	6203716	MHmmp	Pk	2	B	Crest		5	OC	oC	
7/9/2016	17	RD	1241	473039	6203724	MHmmp	Ah	3	C	Level		2d			M
7/9/2016	18	RD	520	473497	6209547	MHmm2	Ws06	6	C	Level	Floodplain	3a			P
7/9/2016	19	RD	513	473520	6209599	MHmm2	Fl02	6	D	Level	No	3b	DC		P
7/9/2016	20	RD	514	473519	6209599	MHmm2	Fm03	6	D	Level	Fm	6	MC	tM	W
7/9/2016	21	RD	264	472245	6216487	ICHvc	Fl04	6	C	Level	Floodplain	3b	YS		W
7/9/2016	22	RD	257	472239	6216494	ICHvc	Fm03	6	D	Level	Fm	7b		tM	M
7/9/2016	23	RD	890	464390	6223597	MHmm2	05	5	D	Toe	No	7b	OC	oC	M
7/9/2016	24	RD	864	464465	6223591	MHmm2	Wf12	7	C	Toe	No	2b			V
7/8/2016	25	RD	1319	455109	6200604	CMAun	At	1	B	Crest		2d			
7/8/2016	26	RD	1293	455087	6200595	CMAun	Rt	0							
7/8/2016	27	RD	1284	454984	6200644	CMAun	Ah	3	C	Lower	No	2d			
7/8/2016	28	RD	1270	454979	6200645	CMAun	Sk	0		Crest		3a			
7/8/2016	29	RD	1418	472514	6203506	MHmmp	Af	0							
7/8/2016	30	RD	1413	472603	6203418	MHmmp	Ah	3	C	Crest		2d			
7/8/2016	31	RD	1415	472734	6203420	MHmmp	Sk	3	C	Upper		3a			W
7/8/2016	32	RD	1412	472733	6203422	MHmmp	Ah	3	C	Crest		2d			W
7/8/2016	33	RD	575	476364	6197954	ICHvc	03	5	D	Lower	No	7b	OC	tM	
7/8/2016	34	RD	617	476363	6197972	ICHvc	01	4	C	Lower	No	7b	OC	tM	
7/8/2016	35	RD	622	476365	6197978	ICHvc	Wf12	7	C	Toe	No	2b			V
7/8/2016	36	RD	1303	473985	6180107	MHmmp	At	1	A	Upper		2d			
7/8/2016	37	RD	1326	473953	6180172	MHmmp	PK	4	C	Upper	No	3b	OC		
7/8/2016	38	RD	1322	473954	6180175	MHmmp	Sk	2	A	Crest		3a	OC		
7/8/2016	39	RD	464	473700	6184147	MHmm2	Fm03	3	C	Level	Fh	6	MC	tM	M
7/8/2016	40	RD	470	473701	6184144	MHmm2	Fm00	2	B	Level	Fm	3a	PS		R
7/8/2016	41	RD	691	472448	6184640	MHmm2	Wf04	7	C	Level		2b			V
7/8/2016	42	RD	704	472442	6184638	MHmm2	Ws00	8	D	Level		6	YC	oC	
7/8/2016	43	RD	719	472494	6184559	MHmm2	01	3	C	Mid		7b	OC	oC	M
7/8/2016	44	RD	1237	466110	6183153	MHmmp	Ah	2	B	Upper		2d			R
7/8/2016	45	RD	1236	466109	6183155	MHmmp	Sk	1	A	Crest		3a			R
7/7/2016	46	RD	150	444375	6217045	CWHwm	01	3	C	Mid		6	MC	tC	W
7/7/2016	47		1461	446393	6205938	CMAun	00	2	A	Crest		1a	PS		
7/7/2016	48	RD	184	444579	6216798	CWHwm	05	5	C	Level	Fh	6	MC	mM	
7/7/2016	49	RD	1200	447087	6213596	CMAun	PK	4	C	Mid		7b		oC	
7/7/2016	50	RD	1260	447123	6213345	CMAun	PK	4	C	Upper		3b	OC		
7/7/2016	51	RD	1304	447174	6213204	CMAun	As	7	D	Lower		2a			
7/7/2016	52	RD	1302	447183	6213181	CMAun	Ah	4	D	Mid		2a			
7/7/2016	53	RD	1305	447195	6213198	CMAun	PK	4	C	Level		3b			

Date	Plot	Plot_Repre
7/9/2016	14	Young poorly developed fen on gravel out wash from glacier. Monoculture of CARESIT with standing water. Fibrotic sedgePeat with SiL lens at depth and mixed into peat. 5% salix 5% EQUIARV glow moss no sphagnum. Grades into wetter areas with no willow
7/9/2016	15	Ws ALNUINC salix horsetail narrow fringe. Floods.
7/9/2016	16	Tree island or parkland forest? Hm Bl VACCMEM, heather. North 20%
7/9/2016	17	Alpine Heath on large bench and slopes.
7/9/2016	18	Ws06 extensive in huge valley bottom. CARESIT and Salix dominate. No moss layered fluvial fines and mesic peat from sedges.
7/9/2016	19	Fl02 extensive with small streams. ALNUINC and lady fern dominate. Equiarv, maxlan, snectri. Some salix.
7/9/2016	20	Fm03 small stand along river. Act Bl ALNUINC dominate. Some dogwood and rich indicators.
7/9/2016	21	Fl04 on gravel bar edge and of river. Thick ALNUINC some salix and red osier dogwood. No moss. Few EQUIARV.
7/9/2016	22	Fmo3 floodplain forest. Very productive and lush. Huge old Act and Bl. Thick dogwood, OPLOHOW, CORNSTO, ALNUINC . Small extent, most along river is young stands.
7/9/2016	23	Toe old hemlock forest above pocket fen. Common in area. 25% at 280
7/9/2016	24	Wf12 best fit. Diverse, sloping wetland. Carex spp, sphagnum, leather, carex aqu, aulapal, caltha, compal or sag, salix bar on edges. 5% slope at 290. Organic greater than 40cm. Carex tissue sample collected
7/8/2016	25	Alpine tundra on ridge and slopes to each side. 290 and 15%
7/8/2016	26	Blocky talus slope.
7/8/2016	27	Alpine Heath
7/8/2016	28	Krumholtz
7/8/2016	29	Shattered bedrock and till. Less than 10% veg
7/8/2016	30	Extensive Heath on flat ridge. Highest goat use, scat, fir, trails in all of RSA by far.
7/8/2016	31	Krumholtz island. Heath all around.
7/8/2016	32	Alpine Heath. Large expanse on flat ridge.
7/8/2016	33	Lower slope below wetland above canyon. No spruce but lots of wet rich indicators. Lady fern, Devils club, salmonberry, leafy mosses. 30 % at 20 degrees
7/8/2016	34	01(1) with sparse Devils club. 35% 330 degrees
7/8/2016	35	Fen. Wf12 best fit. Same as last fen plot so change classification. High diversity, 2% slope, pocket fen. Peat, sedges, leather leaf, compal, veravir, senecio, valerian. Western toad breeding pond. 5 juveniles.
7/8/2016	36	Small patchy alpine tundra
7/8/2016	37	Parkland forest. Mtn hemlock, vacc heather partridge foot valerian
7/8/2016	38	Krumholtz fir and mtn hemlock
7/8/2016	39	Fm03 best fit. Little Devils club. Ribeye, alnus incana, vacc no hair, rattlesnake plantain, goats beard
7/8/2016	40	Fm dryas cottonwood. Extensive
7/8/2016	41	Pocket fen. Wf04 best but poor fit. Diverse in depression by swamp. Check sedge and willow. Deer cabbage c horsetail sedges hook moss peat moss compal erioang
7/8/2016	42	Swamp is 20m at 300 from point.Bl Hm Salic careaqu alnus swamp. Beaver controlled. No classification.
7/8/2016	43	Small steep slope above fen. Hm, Bl, vacc mem, copper bush. 90 degrees. 30%
7/8/2016	44	Alpine Heath. Patchy 50% 340 degrees above Cambria ice shield. White four angle heather, yellow heather, rare partridge foot, 1% crow. No tundra in this area. Some sparse tundra like on higher slopes, all dry exposed shattered bedrock
7/8/2016	45	Krumholtz. Fir and m hemlock crow berry white 4 angle heather closing. Goat scat and hair
7/7/2016	46	Start of mature forest along gravel mine exploration road.
7/7/2016	47	V22
7/7/2016	48	Cottonwood spruce high bench floodplain. Barely mature. 3% slope. No recent flooding.
7/7/2016	49	Parkland forest. 50% 260
7/7/2016	50	Parkland forest. Man hemlock, blueberry, heather. 210 aspect 30%
7/7/2016	51	Unclassified wet seepage slope at start of parkland.50% 240. Horsetail, glow moss, coltsfoot, saxifrage, dwarf willows
7/7/2016	52	Heath meadow. Rich. Diverse. 35% 270 degrees
7/7/2016	53	Tree island. 15 % 220aspect

Date	Plot	Surveyors	Elevation	X	Y	BGC	Site_Serie	SMR	SNR	Mesoslope	Floodplain	Structural	Success_St	Canopy_Com	Drainage
7/7/2016	54	RD	1515	446936	6211871	CMAun	Ah	4	C	Toe		2d			W
7/7/2016	55	RD	1516	446932	6211838	CMAun	At	1	A	Crest		2d			
7/7/2016	56	RD	1507	446925	6211770	CMAun	At	1	A	Crest		2d			
7/7/2016	57	RD	1509	446918	6211771	CMAun	As	5	B	Mid		1a			
7/7/2016	58	RD	1546	446871	6211415	CMAun	At	1	A	Crest		2d			
7/7/2016	59	RD	1575	446888	6211267	CMAun	Af	0		Upper		1a			
7/7/2016	60	RD	1575	446889	6211271	CMAun	Ro	0		Crest		1			
7/7/2016	61	RD	1573	446885	6211269	CMAun	At	0		Crest		2d			
7/7/2016	62	RD	95	442418	6211793	CWHwm	Wm01	0	C	Level	Yes	2b			
7/7/2016	63	RD	1283	438289	6207336	CMAun	Ah	4	C	Level		2d			
7/7/2016	64	RD	1276	438309	6207253	CMAun	Bl	0		Toe		1a			
7/7/2016	65	RD	1280	438272	6207247	CMAun	Sk	0		Upper		3a			
7/7/2016	66	RD	1282	438249	6207209	CMAun	ES	0		Upper					
7/7/2016	67	RD	1257	438194	6207091	CMAun	PK?	0		Crest		3a			
7/7/2016	68	RD	1252	438106	6207078	CMAun	Ah	4	C	Level		2d			
7/7/2016	69	RD	1259	438106	6207055	CMAun	Bl	0							
7/7/2016	70	RD	1246	438103	6207054	CMAun	Bl/Ah	0							
7/7/2016	71	RD	1234	438088	6206816	MHmmp	Am	4	D	Mid		2a			
7/7/2016	72	RD	1240	438094	6206864	CMAun	Sk/Ah	4	C	Upper		3a			
7/7/2016	73	RD	1242	438093	6206863	CMAun	Ah	4	C	Upper	No	2d			M
7/7/2016	74	RD	24	437259	6193672	CWHwm	04	5	D	Toe	No	5	YC	tM	
7/7/2016	75	RD	35	437204	6193693	CWHwm	Em05	7	F	Toe		2b			P
7/6/2016	76	RD	1026	461863	6173796	MHmmp	Sc	6	D	Toe	Fl	2a			
7/6/2016	77	RD	1040	461992	6173590	MHmmp	Sc	6	C		Fl	2d			
7/6/2016	78	RD	1034	461990	6173590	MHmmp	Sk/Ah	0		Crest		3b	OC		W
7/6/2016	79	RD	1009	462300	6173645	MHmmp	Ah	3	D	Lower		2d			
7/6/2016	80	RD	1000	462301	6173644	MHmmp	Sc	0		Level	Fl	3a			
7/6/2016	81	RD	1254	452557	6166194	CMAun	Af	0				1a			
7/6/2016	129	RD	1230	452362	6166321	MHmmp	Sk	0		Upper		3a	OC		
7/6/2016	82	RD	1218	452404	6166343	MHmmp	At	0		Crest		2d			
7/6/2016	83	RD	1222	452498	6166302	CMAun	ES	0		Gully		1			
7/6/2016	84	RD	1227	452443	6166354	MHmmp	Ah	0		Upper		2d			
7/6/2016	85	RD	1220	452534	6166294	CMAun	At	2	B	Crest		2d			
7/6/2016	86	RD	1243	452583	6166249	CMAun	At/As	4	C	Upper		2d			
7/6/2016	87	RD	1251	452557	6166194	CMAun	Ah	0		Upper		2d			
7/6/2016	88	RD	37	449763	6165803	CWHwm	05	5	D	Level	Fh	6	MC	tM	I
7/6/2016	89	RD	1111	450641	6183563	CMAun	RU	0		Toe		1			
7/6/2016	90	RD	2	449395	6165300	CWHwm	Es	0		Level		2b			
7/6/2016	91	RD	5	449329	6165083	CWHwm	Em05	7	F	Level		2b			
7/6/2016	92	RD	6	449392	6165159	CWHwm	Em	7	F	Level		2b			
7/6/2016	93	RD	1160	450712	6183691	CMAun	PN	0							
7/6/2016	94	RD	1117	450646	6183581	CMAun	Af	2	A	Lower		1a			
7/6/2016	95	RD	995	450856	6178688	MHmmp	PN	0							
7/6/2016	96	RD	988	450783	6178663	MHmmp	Bl	0				1			
7/6/2016	97	RD	964	450782	6178663	MHmmp	Ah	0		Crest		2d			
7/6/2016	98	RD	172	446013	6172629	CWHwm	Wb13	0				2b			

Date	Plot	Plot_Repre
7/7/2016	54	Alpine Heath. Extensive. 15-50%. 270 aspect
7/7/2016	55	Alpine tundra
7/7/2016	56	Alpine tundra. Sparse. Rocky
7/7/2016	57	Sparsely vegetated along snowmelt stream. Not a distinct community.
7/7/2016	58	Small alpine tundra on rock ridge
7/7/2016	59	Sparsely vegetated shattered bedrock slope. 60% 250 degrees
7/7/2016	60	Exposed rotten bedrock and shattered bedrock ridge
7/7/2016	61	Alpine tundra
7/7/2016	62	Edge of Wm01 with disturbed areas.
7/7/2016	63	Alpine Heath. Total cover of white heather 4 angle on flat and 80% slope below. 50 aspect. Mbj
7/7/2016	64	Toe of blockfield. Talus like above.
7/7/2016	65	Krumholtz. Mtn hemlock. 20% 130 degrees
7/7/2016	66	Exposed soil and rock
7/7/2016	67	Tree island. Heather partridge for. 3a
7/7/2016	68	Alpine Heath. Pure heather mats. 15% 120 aspect
7/7/2016	69	Small blockfield
7/7/2016	70	Blockfield with Heath heather
7/7/2016	71	Alpine meadow. Marmots. 120 aspect. 75%. Cvs
7/7/2016	72	Mtn hemlock krummholz has and heather. 20% at 120 degrees. Mb
7/7/2016	73	Alpine Heath. 20% 130 aspect
7/7/2016	74	05 5tM toe second growth. 50% slope 310 degrees
7/7/2016	75	Em05 along all delta and shore. Low diversity. Narrow wildrye band before forest
7/6/2016	76	Small alluvial fan with shrub Carr like community. Dominated by deer cabbage.
7/6/2016	77	Small shrub Carr
7/6/2016	78	Small 3b Hm tree island in large heath
7/6/2016	79	Large area of alpine Heath.
7/6/2016	80	Extensive shrub carr with braided channels. Low willow, carex, juncus, scouring rush dominate. High diversity.
7/6/2016	81	Sparsely vegetated near PN
7/6/2016	129	3a Bl Hm krummholz island. Heather, deer cabbage, partridge foot carex nig. 30% Mx over R. Small patches
7/6/2016	82	Alpine tundra with 35% RO
7/6/2016	83	Rocks and exposed soil in gully
7/6/2016	84	Alpine Heath on gentle slope. 15%. Mv over R
7/6/2016	85	Alpine tundra on crest. Mx over R
7/6/2016	86	Small alpine tundra. Wetter areas. High definition shrub and carex nig. Never extensive in area.
7/6/2016	87	Alpine Heath. 20% slope north.
7/6/2016	88	Flat, large Fh well spaced Act and SS. Thick Devils club
7/6/2016	89	Rubble. Like talus at base of steep slopes. Less veg than below.
7/6/2016	90	Upper edge of salt influence. Very diverse. Maxlan, tufted grass, rye, silverweed
7/6/2016	91	Em05 extensive slightly lower than wildrye. Lingby sedge, silverweed 45% each
7/6/2016	92	Extensive rye, silverweed and peavine estuary. Marine silt and clay
7/6/2016	93	Permanent snow
7/6/2016	94	Sparsely vegetated between receding glaciers. 10% cover. Random. No communities. Extensive
7/6/2016	95	Permanent snow
7/6/2016	96	Boulder field at toe recent receded glacier. Extensive. 10-70%
7/6/2016	97	Heath on edge boulder field crest
7/6/2016	98	Wb13 is best fit. Ph 6.5. Firm not floating. 30% OW pond lily buckbean.

Date	Plot	Surveyors	Elevation	X	Y	BGC	Site_Serie	SMR	SNR	Mesoslope	Floodplain	Structural	Success_St	Canopy_Com	Drainage
7/6/2016	99	RD	211	445732	6172568	CWHwm	Wb04	5	D			7b	OC		
7/6/2016	100	RD	200	445734	6172564	CWHwm	Wb00	0				3b			V
7/5/2016	101	RD	266	448715	6209077	CWHwm	SS	0		Level	Fh	7	OC	tM	
7/5/2016	102	RD	343	448686	6209019	CWHwm	4	0		Toe		7	OC	mC	
7/5/2016	103	RD	300	448681	6208978	CWHwm	3	0		Level		7	OC	mC	
7/5/2016	104	RD	344	448710	6208896	CWHwm	1	0		Toe		7	OC	mC	
7/5/2016	105	RD	380	448730	6208804	CWHwm	1	0		Upper		7	OC	mC	
7/5/2016	106	RD	534	448812	6208426	MHmm1	3	0				7	OC	mC	
7/5/2016	107	RD	530	448808	6208420	MHmm1	01	0				7	OC	mC	
7/5/2016	108	RD	685	448982	6208256	MHmm1	01	4	C	DP		7	OC	mC	
7/5/2016	109	RD	775	449016	6208160	MHmm1	3	3	D			7	OC	mC	
7/5/2016	110	RD	815	449009	6208066	MHmm1	1	3	C			7	OC	mC	
7/5/2016	111	RD	752	448977	6208038	MHmm1	1	0				7	OC	mC	
7/5/2016	112	RD	939	449126	6207819	MHmmp	1	0	B	Mid		6	MC	tC	
7/5/2016	113	RD	996	449174	6207680	MHmmp	4	0		Mid		7b	OC	tC	
7/5/2016	114	RD	1209	449431	6207423	CMAun	01	0				7b	OC		
7/5/2016	115	RD	1209	449432	6207421	CMAun	PK	0				5		oC	
7/5/2016	116	RD	1245	449498	6207389	CMAun	PK	0				5		oC	
7/5/2016	117	RD	1300	449735	6207386	CMAun	Ah	0		Mid		2d			
7/5/2016	118	RD	1397	449861	6207008	CMAun	ES	0				1			
7/5/2016	119	RD	1397	449865	6207044	CMAun	Af	0		Mid		1a			
7/5/2016	120	RD	1397	449888	6207036	CMAun	Ah	0		Upper		2d			
7/4/2016	121	RD	1473	454246	6205700	CMAun	Rt	0				1			
7/4/2016	122	RD	1477	454170	6205781	CMAun	Am	0		Mid		2a			
7/4/2016	123	RD	1466	454174	6205778	CMAun	Ah	0		Level		2d			
7/4/2016	124	RD	1466	454129	6205839	CMAun	Af	1	A	Crest		1a			
7/4/2016	125	RD	1452	454020	6205858	CMAun	Af	0		Crest		1b			
7/4/2016	126	RD	1438	454066	6205765	CMAun	Af	0		Crest		1a			
7/4/2016	127	RD	1443	454046	6205752	CMAun	Sk	0		Upper		3a			
7/4/2016	128	RD	1435	454025	6205735	CMAun	Ah	0		Upper		2d			

Date	Plot	Plot_Repre
7/6/2016	99	7b tC man hemlock wet forest. Think vaccmem, step moss, sphagnum, few skunk
7/6/2016	100	Stunted man hemlock, kalium, vacc spp, shores edge. Soil water ph 5.2. Edges of large complex
7/5/2016	101	Mid bench act Ss salmonberry. 7tM on Terrance. Appears common along creek
7/5/2016	102	Steep toe. Prob 04 7mC. Alder thickets
7/5/2016	103	03 7mC flat Mb no slope aspect
7/5/2016	104	01 7mC 80% toe
7/5/2016	105	01 7mC start of 70% slope
7/5/2016	106	03 7mC with streams and 04
7/5/2016	107	CWH 01 7mC
7/5/2016	108	01 7mC. 03 in seepage and small depressions
7/5/2016	109	03 7mC some 01. 60%
7/5/2016	110	01 7mC 65% 300 aspect. Some 03 seepage
7/5/2016	111	01 7mC 50%+
7/5/2016	112	01 6tC on old till landslide by moraine
7/5/2016	113	Prob Mhmm1 04 7b tC. 20% 260 aspect estimated
7/5/2016	114	Start of Mhmm1. 7b oC 60%+ 220 aspect. 01 best for site series. Mix of open 3b and large old hemlock
7/5/2016	115	Pk more developed and taller fir.
7/5/2016	116	Parkland forest. 5oC. 65%. 240 aspect
7/5/2016	117	Alpine Heath. 300 aspect. 40%.
7/5/2016	118	Exposed soil and rock
7/5/2016	119	Exposed soil. 1% cover. Rock and soil. Some PN. NE aspect. 50-70%
7/5/2016	120	Alpine Heath. 50-70 %. North aspect.
7/4/2016	121	Talus slope. RO above. PN beside. 65% SW.
7/4/2016	122	Herb meadow. More mesic with high lichen cover. 25% slope SW aspect.
7/4/2016	123	Heath heather. Large area
7/4/2016	124	Rock and exposed soil. Sparse veg.
7/4/2016	125	Lichen rock dwarf shrubs
7/4/2016	126	Lichen rock vaccinium small area.
7/4/2016	127	Subalpine fir tree island. Small.
7/4/2016	128	Heath heather. Small patches

APPENDIX B. EXPANDED TERRAIN MAPPING LEGEND

Parts of the Terrain Label	Polygon Number	Terrain Symbol: Terrain Component 1 (TC1)	Surface TC1										Sub-surface TC1								
Attribute Table Column Heading	ID2	Tdec_1	PRTFLG_1	TTEX_1C	TTEX_1B	TTEX_1A	SURFM_1	SURFM_Q1	SURFM_ST1	SURF_E1A	SURF_E1B	SURF_E1C	STTEX_1C	STTEX_1B	STTEX_1A	SSURFM_1	SSURFM_Q1	SSURFM_ST1	SSURF_E1A	SSURF_E1B	SSURF_E1C
Example Data	971	8					C		0	v								0			
	969	10	/				C		0	v						R		0	s	h	
	943	2		b	g	s	M		0	v						R		0	u	r	
	965	5	/				O		0	v						M		0	w		
	959	6					C		0	v								0			

Parts of the Terrain Label	Polygon Number	Terrain Component 2 (TC2)	Surface TC2										Sub-surface TC2								
Attribute Table Column Heading	ID2	TDEC_2	PRTFLG_2	TTEX_2C	TTEX_2B	TTEX_2A	SURFM_2	SURFM_Q2	SURFM_ST2	SURF_E2A	SURF_E2B	SURF_E2C	STTEX_2C	STTEX_2B	STTEX_2A	SSURFM_2	SSURFM_Q2	SSURFM_ST2	SSURF_E2A	SSURF_E2B	SSURF_E2C
Example Data	971	2					R		0	h	a							0			
	969	0							0									0			
	943	2		x	s		D		0	v	x					R		0	u	r	
	965	5					C		0	v						M		0	w		
	959	2					R		0	s	r							0			

Parts of the Terrain Label	Polygon Number	Terrain Component 3 (TC3)	Surface TC3										Sub-surface TC3								
Attribute Table Column Heading	ID2	TDEC_3	PRTFLG_3	TTEX_3C	TTEX_3B	TTEX_3A	SURFM_3	SURFM_Q3	SURFM_ST3	SURF_E3A	SURF_E3B	SURF_E3C	STTEX_3C	STTEX_3B	STTEX_3A	SSURFM_3	SSURFM_Q3	SSURFM_ST3	SSURF_E3A	SSURF_E3B	SSURF_E3C
Example Data	971	0							0									0			
	969	0							0									0			
	943	0							0									0			
	965	0							0									0			
	959	2					M		0	v								0			

Parts of the Terrain Label	Polygon Number	Terrain Symbol Continued: Geomorphological Process																		Drainage			Slope				TSM	SEP
Attribute Table Column Heading	ID2	GEOP_1	GEOP_Q1	GEOP_ST1	GEOP_SCM1A	GEOP_SCM1B	GEOP_SCM1C	GEOP_2	GEOP_Q2	GEOP_ST2	GEOP_SCM2A	GEOP_SCM2B	GEOP_SCM2C	GEOP_3	GEOP_Q3	GEOP_ST3	GEOP_SCM3A	GEOP_SCM3B	GEOP_SCM3C	DRAIN_1	DRAIN_SEP	DRAIN_2	SLPLL_1	SLPUL_1	SLPLL_2	SLPUL_2	SLPSTB_CLS	SFCERO_POT
Example Data	971			0						0						0				r			40	60	0	0	S	L
	969	R		0	"		b	A		0	f					0				r			70	120	0	0	U	L
	943			0						0						0				r	-	m	0	30	0	0	S	L
	965			0						0						0				m	-	p	0	20	0	0	S	M
	959	R		0	"		b			0						0				r			60	100	0	0	U	L

Typical Label for Terrain Map

ID2
Tdec_1 Surface TC1 Tdec_2 Surface TC2 Tdec_3 Surface TC3 - Geomorphological Process
Subsurface TC1 Subsurface TC2 Sub-surface TC3
Drainage (concatenate Drain_1, Drain_Sep, Drain2)
Slope (concatenate Slpll_1 - Slpul_1, Slpll_2- Slpul_2)

Examples:

971
8 Cv 2 Rha
r
40 – 60

969
10 /Cv - R"bAf
Rsh
r
70-120

943
8 bgsMv 2 xsDvx
Rur Rur
r-m
0-30

Typical Label for Terrain Stability Soil Erosion Potential Map

ID2
SLPSTB_CLS
SFCERO_POT

Examples:

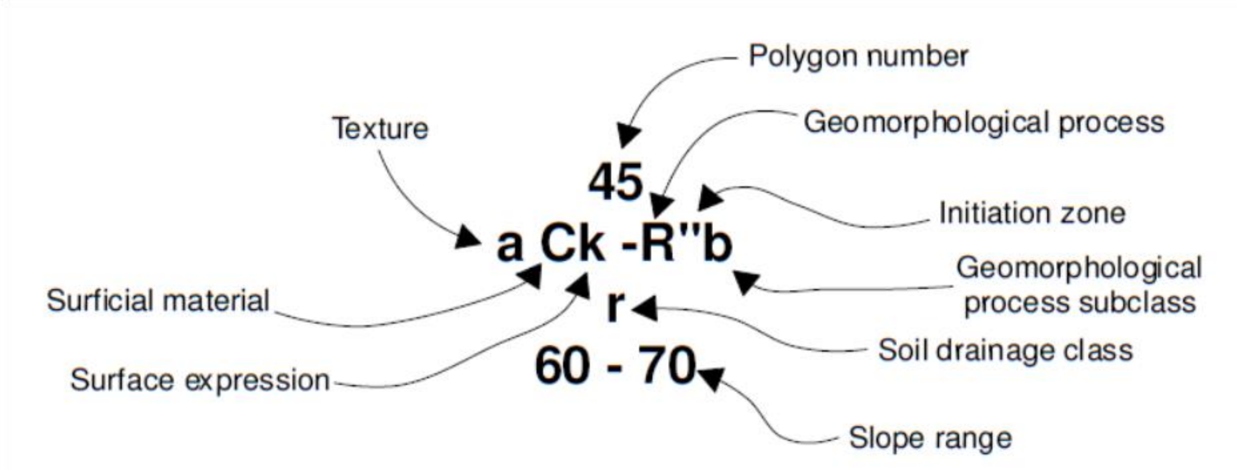
971
S
L

969
U
L

943
S
L

Figure B.1. Explanation of the Spatial Database Attribute Table with respect to the Terrain, Terrain Stability and Soil Erosion data including example polygon labels

Figure B.2. Terrain Map Polygon Label and Legend



1 TERRAIN SYMBOL

Composite Units: Two or three groups of letters are used to indicate that two or three kinds of terrain are present within a map unit.

Examples:

7Mv 3Rs indicates that the polygons contains approximately 70% "Mv" and 30%"Rs".

6Mb 3Cv 1Rs indicates that the polygons contains approximately 60% "Mb", 30%"Cv", and 10% “Rs”.

/Mw indicates "Rk" is partially buried by "Mw"

Rk

Stratigraphic Units: Groups of letters are arranged one above the other where one or more kinds of surficial material overlie a different material or bedrock:

e.g., Mv indicates that "Mv" overlies "Rr".

Rr

Note: one or more letters may be used to describe any characteristic other than surficial material, or letters may be omitted if information is lacking.

Table B.1. Texture (Attribute Table Headings: TTEX_XX and STTEX_XX)

Specific Clastic Terms		
c	clay	< 2 µm
z	silt	2 - 62.5 µm
s	sand	62.5 µm - 2 mm
p	pebbles	2 - 64 mm; rounded particles
k	cobbles	64 - 256 mm; rounded particles
b	boulders	> 256 mm; rounded particles
a	blocks	> 256 mm; angular particles
Common Clastic Terms		
d	mixed fragments	subrounded and subangular particles of all sizes
x	angular fragments	mixture of rubble (r) and blocks (a)
g	gravel	mixture of pebbles (p), cobbles (k), boulders (b) and up to 20% sand
r	rubble	angular particles < 64 mm
m	mud	mixture of sand (s) and silt (z)
y	shells	
Organic Terms		
e	fibric	
u	mesic	
h	humic	

Table B.2. Surficial Material (Attribute Table Headings: SURFM_X and SSURFM_X)

A	Anthropogenic materials	Artificial materials and materials modified by human actions such that their original physical appearance and properties have been drastically altered.
C	Colluvium	Products of gravitational slope movements; materials derived from local bedrock and major deposits derived from drift; includes talus and landslide deposits. Includes up to 20% bedrock.
CG	Glaciocolluvial	Debris flow (colluvium) material deposited during Fraser Glaciation and Little Ice Age glaciation.
D	Weathered bedrock	Bedrock modified *in situ* by mechanical and chemical weathering.
E	Eolian sediments	Sand and silt transported and deposited by wind; includes loess.
F	Fluvial sediments	Sands and gravels transported and deposited by streams and rivers; floodplains, terraces and alluvial fans.
FA	"Active" fluvial sediments	Active deposition zone on modern floodplains and fans; active channel zone.
FG	Glaciofluvial sediments	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers and outwash plains.
I	Ice	Areas of snow and ice where evidence of active glacier movement is present
L	Lacustrine sediments	Fine sand, silt and clay deposited in lakes.
LG	Glaciolacustrine sediments	Fine sand, silt and clay deposited in ice-dammed lakes.
M	Till (moraine)	Material deposited by glaciers without modification by flowing water. Typically consists of a mixture of pebbles, cobbles and boulders in a matrix of sand, silt and clay; diamicton. Includes up to 20% bedrock and/or colluvium.
M1	Lateral moraine	Unconsolidated debris deposited along the sides of a glacier to create ice-marginal ridges. After glacial ice has melted, lateral moraine consists of steep-sided ridges along the valley sides.
N	Non-classified	Non-classified, for example, lake.
O	Organic materials	Material resulting from the accumulation of decaying vegetative matter; includes peat and organic soils.
R	Bedrock	Outcrops and bedrock within a few centimetres of the surface. Includes up to 20% colluvium.
U	Undifferentiated materials	Different surficial materials in such close proximity that they cannot be separated at the scale of the mapping.

Table B.3. Surface Expression (Attribute Table Headings: SURF_XXX and SSURFM_XXX)

a	moderate slope(s)	predominantly planar slopes; 15-26º (28 - 49%)
b	blanket	material >1-2 m thick with topography derived from underlying bedrock (which may not be mapped) or surficial material
c	cone	a fan-shaped surface that is a sector of a cone; slopes 15º (27%) and steeper
d	depression	enclosed depressions
f	fan	a fan-shaped surface that is a sector of a cone; slopes 3-15º (5-27%)
h	hummocky	steep-sided hillocks and hollows; many slopes 15º (27%) and steeper
j	gentle slope(s)	predominantly planar slopes; 4-15º (6 - 27%)
k	moderately steep slope	predominantly planar slopes; 26-35º (50 - 70%)
m	rolling topography	linear rises and depressions; < 15º (27%)
p	plain	0-3º (0-5%)
r	ridges	linear rises and depressions with many slopes 15º and steeper
s	steep slope(s)	slopes steeper than 35º (> 70%)
t	terrace(s)	stepped topography and benchlands
u	undulating topography	hillocks and hollows; slopes predominantly <15º
v	veneer	material <1-2 m thick with topography derived from underlying bedrock (may not be mapped) or surficial materials; may include outcrops of underlying material
w	mantle	surficial material of variable thickness
x	thin veneer	a subset of v (veneer), where there is a dominance of surficial materials about 10-25 centimetres thick

Table B.4. Geomorphological Processes (Attribute Table Headings: GEOP_X)

A	Snow avalanche	Rapid downslope movement of snow and ice by flowing or sliding.
E	Glacial meltwater channels	Areas crossed by meltwater channels that are too small or too numerous to map individually.
B	Braiding Channel	Active channel zone characterized by many diverging and converging channels separated by unvegetated bars.
F	Failing	Slope experiencing slow mass movement, such as sliding or slumping
I	Irregularly Sinuous Channel	A clearly defined channel displaying irregular turns and bends, back channels may be present.
L	Surface seepage	Zones of active seepage often found along the base of slope positions.

M	Meandering channel	A clearly defined channel characterized by a regular and repeated pattern of bends.
R	Rapid mass movement	Slope or parts of slope affected by processes such as debris flows, debris slides and avalanches, and rockfall
S	Solifluction	Slow gravitational movement of saturated non-frozen overburden across a frozen or otherwise impermeable substrate.
V	Gullying	Slope affected by gully erosion.

Table B.5. Geomorphological Process Subclass (Attribute Table Headings: GEOP_XXXXX)

-F	slow mass movement
-F"	slow mass movement - initiation zone
-Fg	rock creep (slow movement of angular debris under periglacial conditions)
-Fm	slump in bedrock
-R	rapid mass movement
-R"	rapid mass movement - initiation zone
-Rb	rock fall
-Rd	debris flow
-Rs	debris slide
-Rt	debris flood (debris torrent)

Table B.6. Soil Drainage Class (Attribute Table Headings: DRAIN_X)

x	very rapidly drained	water is removed from the soil very rapidly in relation to supply
r	rapidly drained	water is removed from the soil rapidly in relation to supply
w	well drained	water is removed from the soil readily but not rapidly
m	moderately well drained	water is removed from the soil somewhat slowly in relation to supply
i	imperfectly drained	water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season
p	poorly drained	water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen
v	very poorly drained	water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen
Where two drainage classes are shown: - if the symbols are separated by a comma, e.g., "w,i", then no intermediate classes are present; - if the symbols are separated by a dash, e.g., "w-i", then all intermediate classes are present		

Slope Steepness Range (Attribute Table Headings: SLPLL_X)

Slopes are given in percentages as a range. For example, '20-45' indicates that the majority of the slopes in the polygon are between 20% and 45%.

Figure B.3. Terrain Stability and Soil Erosion Potential Map Polygon Label and Legend

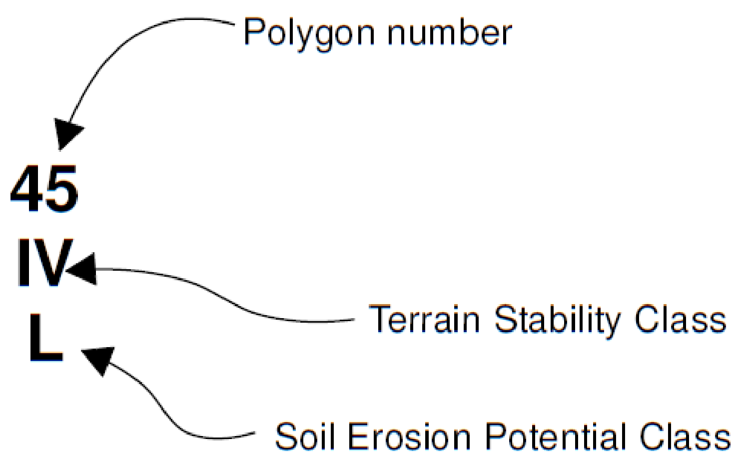


Table B.7. Terrain Stability Class (Attribute Table Heading: SLPSTB_CLS)

Class	Rating	Implication
I	Negligible	No significant stability problems exist.
II	Very Low	There is a very low likelihood of landslides following mining-related construction. Minor slumping is expected along cut slopes, especially for one or two years following construction.
III	Low	Minor stability problems can develop. Minor slumping is expected along cutslopes, especially for one or two years following construction. There is a low likelihood of landslide initiation following mining-related construction.
IV	Moderate	Expected to contain areas with a moderate likelihood of landslide initiation following mining-related construction.
V	High	Expected to contain areas with a high likelihood of landslide initiation following mining-related construction.

Source: B.C. Ministry of Forests (1999)

Table B.8. Soil Erosion Potential Class (Attribute Table Heading: SFCERO_POT)

Class	Rating	Implication
VL	Very Low	Negligible or very minor soil erosion.

L	Low	Expect minor erosion of fines from bare soils.
M	Moderate	Expect moderate erosion when water is channeled onto bare surfaces.
H	High	Significant erosion problems can be created when water is channeled onto or over exposed soil on these sites.
VH	Very High	Severe surface and gully erosion problems can be created when water is channeled onto or over these sites.

Source: B.C. Ministry of Forests (1999).

GENERAL CONDITIONS

The bioterrain and terrain stability mapping completed by Polar Geoscience Ltd. incorporates and is subject to these general conditions:

Use of Report

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than to which it refers. Any variation from the site or development would necessitate a supplementary assessment.

This report and the recommendations contained herein are intended for the sole use of Polar's client. Polar does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any other party than Polar's client unless otherwise authorized in writing by Polar. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Polar. Additional copies of the report, if required, may be obtained upon request.

Nature and Exactness of Soil, Surficial Material and/or Rock Descriptions

Classification and identification of soils, surficial materials, and rocks are based upon commonly accepted methods employed in geoscience practice. This report contains descriptions of the methods used. Where deviations from these methods prevail, they are specifically mentioned.

Classification and identification of geological units or terrain polygons are judgmental in nature as to both type and condition. The information and interpretations presented in this report must be applied with due recognition of the inherent limitations associated with the use of remote sensing information, including aerial photos. Where such information is used, it should be recognized that while such information may reasonably represent the conditions on the ground at the same scale and date as that of the photos, any mapping or interpretations based on the information cannot be expected to reflect variations occurring on smaller spatial scales or changes that may occur after the date the information was collected. In addition, there is a limited level of accuracy associated with the procedure. Field inspections are useful in confirming the spatial extent and likely depth of a given soil or surficial material, but they are by definition inspections of the ground surface; our judgment concerning the three dimensional extent of the material are the product of interpretation of information available at the surface. In addition, no areas in this assignment were field checked, which further limits the mapping accuracy.

The present report represents the current information available; it is valid for the condition of the study (assessment) area as of the date of the information, verified by observations on the date of the field review. If further information or observations become available, the interpretations and conclusions contained within this report may require updating.

Polar does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in geoscience practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified professional(s) should revisit the site and review recommendations in light of the actual conditions encountered.

Stratigraphic and Geological Information

Any stratigraphic and geological information indicated on drawings contained in this report are inferred from surface observations and/or shallow hand dug test pits and/or soil/rock exposures. Stratigraphy is known only at the locations of the test holes or exposures. Actual geology and stratigraphy may vary from that presented in this report. Natural variations in geological conditions are inherent and are a function of the historic environment. Polar does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

Surface Water and Groundwater Conditions

Any surface water and groundwater conditions that are mentioned in this report are those observed at the times recorded in the report. These conditions vary with location, time, development activity, and in response to special meteorological conditions. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology, and development activity. Deviations from these observations may occur during the course of development activities. Where surface water or groundwater conditions encountered during development are different from those described in this report, qualified professional(s) should revisit the site and review recommendations in light of actual conditions encountered.

Observations during Development

Because the nature of geological deposits, the judgmental nature of the assessment, as well as the potential adverse circumstances arising from development activity, observations during site preparation, excavation and construction should be carried out by a qualified professional, where specified in this report. These observations may then serve as the basis for confirmation and/or alteration of recommendations presented herein.

Standard of Care

Services performed by Polar for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the results, comments, recommendations, or any other portion of this report.

Environmental and Regulatory Issues

Unless stipulated in the report, Polar has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

APPENDIX C. SURFICIAL MATERIALS

APPENDIX C. SURFICIAL MATERIALS

1.1 TILL (M) AND (M1)

Till is deposited directly by glaciers and usually exists as a veneer (Mv), blanket (Mb), or mantle of variable thickness (Mw) over the underlying bedrock surface. It typically consists of a fine-grained matrix (particles <2 mm) that surrounds and supports clasts (particles >2 mm) of a variety of sizes, shapes and rock types. Till characteristics, such as texture (i.e., particle sizes) and consolidation (or bulk density), vary according to specific processes of deposition by glacier ice (e.g., subglacial vs. supraglacial tills). These deposits can be highly variable and gradations in texture and consolidation can vary over short distances.

Basal till (i.e., subglacial till) is deposited at the base of a glacier creating highly consolidated material. As a result, basal till has a relatively low permeability and commonly acts as an impermeable layer. It tends to be the strongest of all surficial materials.

Till mapped with the subtype “1”, for example M1, is applied till deposited as lateral moraine during the Little Ice Age. These deposits tend to occur on the mid and lower slopes, are loosely consolidated and generally well drained. On slopes steeper than about 60%, these sediments are actively failing.

1.2 COLLUVIUM (C) AND (CG)

Colluvium has accumulated during post-glacial times as a result of gravity-induced slope movement, for example, rock fall and soil creep. The physical characteristics of colluvium are closely related to its source and mode of accumulation. Four processes generally create colluvial deposits: (1) rockfall from bedrock bluffs, (2) soil creep in weathered bedrock, (3) mass movement processes in surficial materials (debris flows and debris slides), and (4) rockslides and rock slumps.

Rockfall from bedrock bluffs typically forms talus slopes (Ck). Talus is loosely packed rubble or blocks with little interstitial silt and sand near the surface, and is rapidly drained.

Colluvial veneers (Cv) and colluvial blankets (Cb) develop where weathered bedrock or surficial materials have been loosened and moved downslope by gravitational processes such as soil creep. It is loosely packed and usually well drained.

Colluvial fans (Cf) and colluvial cones (Cc) form at the base of steep gullies and colluvial materials make up the steeper creek channels (Cj) due to deposition by debris flows (-Rd). These deposits are generally compact, and sorting may range from poorly sorted to well sorted. The deposit may or may not be matrix supported, and the matrix is usually sand.

Deep-seated slumps in bedrock and surficial materials result in hummocky, irregular colluvial deposits (Chu). Rock slumps contain blocks and rubble with little or no interstitial silt and sand.

Glaciocolluvial (CG) is applied to fans formed by debris flows deposited during the Little Ice Age. As the base level has lowered since Little Ice retreat, these fans appear as raised terraces perched on the lower valley sides and are dissected by the present day creeks. Raised fans may have larger clast sizes than their modern counterpart and are likely drier than their modern counterpart.

1.3 Glaciofluvial Materials (FG)

Glaciofluvial materials were deposited by glacial meltwater streams near the end of the most recent glaciation. Sand and gravel accumulated along ice margins and on top of melting ice (FGu) (i.e., ice contact deposits), and downstream of glaciers (FGp) (i.e., outwash plains). Where outwash streams flowed onto flat ground, fans (FGf) were formed. Where outwash streams drained into former lakes, deltas (FGf and FGp) were created. Postglacial streams have incised into some outwash plains and fans transforming them into terraces (FGt) and scarps (FGk).

Glaciofluvial materials consist of sand and gravel with small quantities of finer material and are potential sources of aggregate. Sorting and bedding characteristics are variable depending on the mode and site of deposition. Gravels range from unsorted to well-sorted and bedding can range from absent to well-defined. Glaciofluvial deposits are loose (uncompacted) and clasts tend to be more subrounded than subangular. Ice-contact deposits may have distorted bedding, slump structures and faults as a result of settling and collapse due to the melting of supporting ice. Ice contact deposits may also contain lenses of fine-textured glaciolacustrine sediments and coarse-textured ablation till. Beds in raised deltas are inclined up to 40%, and indicate the frontal slopes of depositional landforms.

1.4 Fluvial Materials (F)

Fluvial materials include sands and gravels transported and deposited post-glacially by streams. These sediments are loose, non-cohesive and highly porous and permeable. Associated landforms, such as floodplains (Fp, FAp) and parts of fans that are close to stream-level, have high water tables and are moderately to imperfectly drained. Floodplains are subject to periodic inundation during high flows. Fluvial terraces (Ft) stand above present day creek-levels, are relatively well drained and dry.

1.5 Glaciolacustrine (LG)

Glaciolacustrine materials have been deposited in glacial or ice-dammed lakes that were present during and shortly after glaciation. Glaciolacustrine materials generally consist of well to moderately well stratified fine sand, silt and/or clay with occasional lenses of till or glaciofluvial material. Glaciolacustrine materials are generally only slowly permeable, and so the presence of even a thin layer of this material is sufficient to cause impeded drainage, perched water tables, and surface seepage. These conditions may promote instability in some situations. These fine-textured materials are also susceptible to surface erosion by running water.

1.6 ANTHROPOGENIC MATERIAL (A)

Anthropogenic materials are deposits that are sufficiently reworked or redistributed by human activities that their original character is lost. Examples include gravel pits and fill used for roads and other construction.

APPENDIX D. GEOMORPHOLOGICAL PROCESSES

APPENDIX D. GEOMORPHOLOGICAL PROCESSES

Natural hazards within this report include mass movement geomorphological processes that may represent a hazard to life, property or the environment. This includes landslides, slumps, rockfall and snow avalanches (i.e., processes that can be reasonably inferred based on the air photos). Natural hazards not considered during this project include seismicity (i.e., earthquakes) and flooding. Polygons that contain natural hazards include geomorphological labels in the attribute table of the spatial database. These labels describe the natural hazard type and whether the polygon contains the initiation zone or deposition zone of the mass movement process.

This report provides an inventory of natural hazards, specifically mass movement processes. The scope of this assignment did not include determination of magnitude, frequency, and/or consequence of the natural hazards, and thus it is not considered a natural hazard risk assessment. The natural hazards mapping indicates the current distribution of mass movements based on the visual evidence identified during the air photo review. Knowledge of where existing natural hazards and potential natural hazards (TS class IV and V polygons) are located provides direction to focus future detailed geohazard risk assessments.

Rapid mass movement refers to downslope movement by falling, rolling or sliding of debris derived from surficial material and/or bedrock. Where a double prime symbol (”) is used with a mass movement process (e.g., -R”s), slope failure has initiated within the polygon. Mass movement symbols without the double prime symbol (e.g., -Rb) indicate a polygon that contains the transport or deposition zone of rapid mass movement. Transportation zones are generally not recognized as areas where landslides initiate; they may contribute additional volume of transported material to a failure. Transport and deposition zones represent hazardous areas downslope of slides or rockfall.

The natural hazards and other geomorphological processes mapped in the Study Area are described below.

1.1 DEBRIS SLIDES (-R”S) AND DEBRIS FLOWS (-R”D)

Debris flows (-Rd) generally initiate in steep gullies and debris slides (-Rs) initiate on steep hillsides. They occur when a mass of surficial material slides rapidly downslope often as a result of the loss of soil strength due to high pore water pressure. Debris slides (non-channelized movement of debris) and debris flows (channelized movement of debris) are initiated on steep slopes where material slides along a shear plane. The shear plane often coincides with the boundary between more permeable and less permeable material (e.g. between weathered and unweathered material or between surficial material and bedrock). Debris flows and debris slides are triggered by heavy rain, water from snow melt, and/or rain on snow events, and result from loss of soil strength due to high pore water pressure. During wet conditions, slides are also triggered by wind stress on trees, tree throw, impact of falling rocks from up slope, and vibrations due to earthquakes or human activity.

There is a potential for increased probability of landslides following road and trail building and forest cover removal (Pike *et al*, 2010). We recommend that this is taken into account during the geohazard field assessment. In logged areas, debris slides that occur several years after logging can be due to the loss of soil strength that results from root decay. In the interior region of British Columbia, past studies show that 80% of development-related slides occur from roads, and most of the cutblock-related slides occur from skid roads (Pike *et al*, 2010).

Some reasons cited for failures initiating from resource roads and trails include (Pike *et al*., 2010):

- weak fill slopes in road prism;
- inadequate or poor road drainage;
- culvert water is discharged onto an unstable slope;
- more water is intercepted by the road cut (i.e. daylighting near-surface seepage) than was anticipated during road design; and
- water is redirected due to blocked culvert or cross-ditch downslope onto potentially unstable terrain.

A debris flow may move downslope for several hundred metres or more before it is arrested by gentler terrain or by de-watering, or it may enter a trunk stream. Debris flows are effective agents of erosion, commonly increasing the volume of material as it progresses downslope. Debris slides and debris flows are significant potential sources of stream sediment and are a hazard to activities or structures (e.g., roads, culverts) located in runout zones.

1.2 Rock Fall (-R"b)

Rockfall (-Rb, -R"b) occurs when either a single block or a mass of bedrock falls, bounces and rolls downslope. In the Study Area, rockfall from local outcrops creates talus slopes, colluvial veneers and blankets.

1.3 Debris Flood (-R"t)

A debris flood is a rapid surging flow of water containing debris that occurs generally in second or higher order channels (moderate to moderately steep channels). Debris floods commonly settle out at slopes less than 10 degrees (e.g. on gently sloping colluvial fans).

1.4 Rock Slumps (-F"m)

A slump in bedrock refers to a rotational slump where portions of the slide mass remain internally cohesive. Rotational slumps develop due to failure along vertical joints and horizontal weak layers.

1.5 Rock Creep (-F"g)

Rock creep involves the slow movement of debris under periglacial (i.e. rock glaciers) or other conditions. Rock glaciers are an expression of mountain permafrost. Their internal structure consists of rocks, sand, and silts cemented by ice. Unlike pure glaciers, rock glaciers creep through internal deformation of interstitial ice at rates from several centimetres per year to one metre per year.

1.6 Snow Avalanche (-A)

Snow avalanches are rapid slides and flows of snow. Rocky and vegetative material is commonly transported by the snow. They present a hazard to winter and spring activities, and accumulated avalanche snow can delay the opening of roads in the spring. Removal of forest adjacent to the runout zone of an avalanche track may result in extension of the runout distance. A buffer of forest between the development area and the avalanche track can reduce the likelihood of this impact. For this report, the geomorphological process for avalanche polygons containing avalanches as visible on the 2013 air photos and should be considered a general "snapshot in time" inventory of avalanches. It is recommended that an avalanche risk assessment is conducted for this project.

1.7 Abundant Seepage (-L)

Seepage is mapped where relatively wet soils are widespread in a polygon. This commonly occurs where soils are on slowly permeable materials such as till, where thin surficial materials overlie bedrock, and on lower slopes where shallow subsurface water is received from a relatively large catchment area further upslope. They may also occur where groundwater is concentrated at the surface by a physical conduit such as a geological fault.

1.8 Gully Erosion (-V)

Gullies are small ravines typically with V-shaped cross sections that can form in either glacial material or bedrock. Gully erosion has been mapped in two kinds of terrain: (i) slopes with several parallel shallow gullies in thick surficial materials (dissected slope) and (ii) single gullies where streams have exploited joints in bedrock or have cut down into thick surficial materials. Gullied terrain is an indicator of either former or active erosion, and the symbol serves to identify material that is potentially subject to erosion or mass movement (e.g., Uk-V). Gully sideslopes and steep headwalls are common sites of slope failures and are classed as potential unstable (Class IV) where there is no evidence of instability and unstable (Class V) where there is evidence of instability.

1.9 Channeled by Meltwater (-E, -EV)

Meltwater channels form alongside, beneath, or in front of a glacier or ice sheet. Glacial meltwater channels are typically sinuous in plan, flat-floored, and steep-sided in cross-section. The floors of the meltwater channel may contain glaciofluvial sediments, indicative of the water flow that once took place here. Meltwater channels are present near the valley bottom of Harper Creek.

1.10 Ground Disturbance (-G)

Ground disturbance refers to anthropogenic excavations where the remaining exposed surface has remained undisturbed and is *in-situ*; for example, the cutslopes in gravel pits, housing developments, and road cuts.

1.11 Periglacial Processes (-Z, -S, -C, -N)

Periglacial processes result from the effects of frost (freezing and thawing) and are common in alpine areas. The processes include solifluction (slow downslope movement of soil and weathered material), nivation (small depressions eroded by freeze-thaw adjacent to snow patches) and cryoturbation (heaving and churning of soils by freeze-thaw).

APPENDIX E. EXPANDED TEM LEGEND

Appendix E. Expanded TEM Legend

Site Modifiers

Site modifiers are used to describe atypical conditions for each ecosystem (Table 1; RISC 1998). Each site series in the BEC system has a known set of typical conditions. As ecosystem often have a certain amount of variability, site modifiers can be used to describe why a given ecosystem type is being mapped in an atypical condition. The atypical conditions include topography (including aspect), moisture and soils.

Table E.1. Site Modifiers (adapted from RISC, 2010)

Code	Description
c	coarse-textured soils
d	deep soils (> 1m)
f	fine-textured soils
g	gullying
h	hummocky
j	gentle (<25% in the interior; <35% in the CDF, CWH and MH zones)
K	cool aspect (285 – 135°) slope (26% – 100%)
m	medium-textured soils
n	fan/cone
p	peaty material
q	very steep (>100%) cool aspect (135 – 285°) slope
r	ridge
s	shallow soils (20-100 cm)
t	terrace
v	very shallow soils (<20 cm)
w	warm aspect (135 – 285°) slope (26% – 100%)
z	very steep (>100%) warm aspect (135 – 285°) slope

Structural Stage and Modifiers

Structural stage codes and structural stage modifiers are used to describe the vegetation structure and appearance in each ecosystem unit (Tables 2 and 3). Structural stage codes describe the relative age of a given ecosystem (i.e., shrub dominated vs. old growth forest) while the modifiers are used to provide additional descriptions of structural stages. (BC Ministry of Forests and Range and BC Ministry of Environment 2010).

Table E.2. Structural Stage Codes (adapted from MFR & MOE 2010)

Structural Stage	Description
Post-disturbance stages or environmentally induced structural development	
1 Sparse/bryoid	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance less than 20 years for normal forest succession, may be prolonged (50-100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover less than 20%; total tree layer cover less than 10%.
1a Sparse	Less than 10% vegetation cover
Stand initiation stages or environmentally induced structural development	
2 Herb	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover less than 10%, shrub layer cover less than or equal to 20% or less than 1/3 of total cover, herb-layer cover greater than 20%, or greater than or equal to 1/3 of total cover; time since disturbance less than 20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
2a Forb-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid-dominated	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub-dominated	Dominated by dwarf woody species such as heather and dwarf willows.
3 Shrub/Herb	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover less than 10%, shrub layer cover greater than 20% or greater than or equal to 1/3 of total cover.
3a Low shrub	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 20 years for normal forest succession.

Structural Stage	Description
3b Tall shrub	Communities dominated by shrub layer vegetation that are 2-10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
Stem exclusion stages	
4 Pole/Sapling	Trees greater than 10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually greater than 10-15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy–this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually less than 40 years for normal forest succession; up to 100+ years for dense (5000-15,000+ stems per hectare) stagnant stands.
5 Young Forest	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40-80 years but may begin as early as age 30, depending on tree species and ecological conditions.
Understory re-initiation stage	
6 Mature Forest	Trees established after the last disturbance have matured; a second cycle of shade-tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80-140 years for biogeoclimatic group A and 80-250 years for group B.
Old-growth stage	
7 Old Forest	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally greater than 140 years for biogeoclimatic group A and greater than 250 years for group B.

Table E.3. Structural Stage Modifiers (adapted from RISC, 2010)

Modifier	Description
s single-storied	Closed forest stand dominated by the overstorey crown class (dominant and co-dominant trees); intermediate and suppressed trees account for less than 20% of all crown classes combined, advance regeneration in the understory is generally sparse.
t two-storied	Closed forest stand co-dominated by distinct overstorey and intermediate crown classes; the suppressed crown class is lacking or accounts for less than 20% of all crown classes combined′ advance regeneration is variable.
m multi-storied	Closed forest stand with all crown classes well represented; each of the intermediate and suppressed classes account for greater than 20% of all crown classes combined, advance regeneration is variable
o open	Forest stand with very open main and intermediate crown classes (totaling less than 25% cover); substantial understorey light levels commonly result in well-developed shrub and/or herb understorey.

Stand Composition modifiers

Stand composition modifiers are used to provide additional descriptions of structural stages 3 to 7 and indicate the dominance of the stand by broadleaf, conifers or a mixed forest (Table 4; RISC 2010).

Table E.4. Stand Composition Modifiers (adapted from RISC 2010)

Modifier	Description
C - coniferous	Greater than 3/4 of total tree layer cover is coniferous.
B - broadleaf	Greater than 3/4 of total tree layer cover is broadleaf.
M - mixed	Neither coniferous nor broadleaf account for greater than 3/4 of total tree layer cover.

APPENDIX F. POTENTIAL CDC LISTED ECOSYSTEMS IN THE RSA

Scientific Name	English Name	Prov Status	BC List	Identified Wildlife	Biogeoclimatic Units	Ecosystem Group
Abies amabilis - Tsuga mertensiana / Gymnocarpium dryopteris Moist Maritime 1	amabilis fir - mountain hemlock / oak fern Moist Maritime 1	S4	Yellow		MHmm1/03	Terrestrial - Forest: Coniferous - mesic
Abies amabilis - Tsuga mertensiana / Gymnocarpium dryopteris Moist Maritime 2	amabilis fir - mountain hemlock / oak fern Moist Maritime 2	S4	Yellow		MHmm2/03	Terrestrial - Forest: Coniferous - mesic
Abies amabilis - Tsuga mertensiana / Streptopus lanceolatus	amabilis fir - mountain hemlock / rosy twistedstalk	S4	Yellow		MHmm1/05;MHmm2/05	Terrestrial - Forest: Coniferous - mesic
Alnus incana / Cornus stolonifera / Athyrium filix-femina	mountain alder / red-osier dogwood / lady fern	S3	Blue		ICHmc2/Fl02;ICHvc/52;ICHvc/Fl02;ICHwc/52;ICHwc/Fl02;ICHwk1/Fl02;ICHwk4/Fl02;SBSdk/Fl02;SBSmk2/Fl02;SBSvk/Fl02;SBSwk1/Fl02	Terrestrial - Flood: Flood Lowbench (Fl)
Alnus incana / Equisetum arvense	mountain alder / common horsetail	S3	Blue		BWBSdk/Fl01;CWHwm/Fl01;ICHvc/Fl01;ICHvk1/Fl01;MSxv/Fl01;SBSvk/Fl01	Terrestrial - Flood: Flood Lowbench (Fl)
Alnus incana / Spiraea douglasii / Carex sitchensis	mountain alder / hardhack / Sitka sedge	S3S4	Yellow		CWHwm/Ws02;ESSFwv/Ws02;ICHmc2/Ws02;ICHvc/Ws02;ICHwk1/Ws02;MSdm1/Ws02;MSmw1/Ws02;SBSmc2/Ws02;SBSwk1/Ws02	Wetland - Mineral: Wetland Swamp (Ws)
Carex lyngbyei Herbaceous Vegetation	Lyngbye's sedge herbaceous vegetation	S2	Red		CDFmm/Em05;CWH/Em05	Estuarine: Estuary Marsh (Em)
Carex sitchensis / Sphagnum spp.	Sitka sedge / peat-mosses	S2	Red		CWHvh2/Wf51;CWHvm1/Wf51;CWHvm2/Wf51;CWHwh1/Wf51;CWHwm/Wf51;CWHws2/Wf51;ICHvc/Wf51;ICHwc/Wf51;MHmm1/Wf51	Wetland - Peatland: Wetland Fen (Wf)
Carex utriculata - Carex aquatilis	beaked sedge - water sedge	S4	Yellow		BWBSdk/Wm01;BWBSmk/Wf01;BWBSmk/Wm01;BWBSmw/Wf01;BWBSwk1/Wf01;ESSFdc3/Wf01;ESSFdk1/Wf01;ESSFdk2/Wf01;ESSFdv/Wm01;ESSFdv2/Wm01;ESSFmc/Wf01;ESSFmc/Wm01;ESSFmw/Wf01;ESSFmw/Wm01;ESSFwc1/Wf01;ESSFwk1/Wf01;ESSFxc/Wf01;ESSFxc/Wm01;ESSFxv1/Wf01;ESSFxv2/Wf01;ESSFxv2/Wm01;ICHmc1/Wm01;ICHmc2/Wm01;ICHmk1/08;ICHmk1/Wf01;ICHvc/Wf01;ICHwc/Wf01;ICHwk1/Wm01;ICHwk2/Wm01;IDFdk1/Wm01;IDFdk2/Wm01;IDFdk3/Wf01;IDFdk3/Wm01;IDFdk4/Wf01;MHmm2/Wf01;MSdc1/Wf01;MSdc1/Wm01;MSdc2/Wm01;MSdc3/Wf01;MSdc3/Wm01;MSdk/Wm01;MSdm1/Wf01;MSdm1/Wm01;MSdm2/Wf01;MSdm2/Wm01;MSdm3/Wm01;MSdm3w/Wm01;MSmw1/Wf01;MSmw2/Wf01;MSxk/Wf01;MSxk/Wm01;MSxv/Wf01;MSxv/Wm01;PPxh1/Wm01;SBPSdc/Wm01;SBPSxc/Wm01;SBSdk/Wm01;SBSdw1/Wm01;SBSdw3/Wm01;SBSmc2/Wm01;SBSmk1/Wm01;SBSmk2/Wm01;SBSvk/Wm01;SBSwk1/Wm01	Wetland - Mineral: Wetland Marsh (Wm);Wetland - Peatland: Wetland Fen (Wf)
Deschampsia cespitosa ssp. *beringensis - Hordeum brachyantherum*	tufted hairgrass - meadow barley	S2	Red		CDFmm/Ed01;CWH/Ed01	Estuarine: Estuary Meadow (Ed)

Scientific Name	English Name	Prov Status	BC List	Identified Wildlife	Biogeoclimatic Units	Ecosystem Group
Deschampsia cespitosa ssp. beringensis - Symphyotrichum subspicatum	tufted hairgrass - Douglas' aster	S2	Red		CDFmm/Ed02;CWH/Ed02	Estuarine: Estuary Meadow (Ed)
Eriophorum angustifolium / Sphagnum spp.	narrow-leaved cotton-grass / peat-mosses	S3S4	Yellow		CWHvm1/Wf50;MHmm1/Wf50	Wetland - Peatland: Wetland Fen (Wf)
Leymus mollis ssp. *mollis* - *Lathyrus japonicus*	dune wildrye - beach pea	S1S2	Red		CDFmm;CWHdm;CWHds1;CWHms2;CWHvh1;CWHvh2;CWHvm1;CWHwh1;CWHwm;CWHws1;CWHxm1;CWHxm2	Terrestrial - Beach: Beach Beachland (Bb)
Picea engelmannii x *glauca / Equisetum* spp.	hybrid white spruce / horsetails	S5	Yellow		ICHdk/09;ICHmk1/07;ICHmk2/06;ICHvc/06;ICHwc/08;IDFdk1/06;IDFdk2/06;IDFdm1/07;IDFdm2/07;IDFdw/10;IDFxh2/08;IDFxm/09;MSdk/06;SBPSmc/05;SBSdh1/07;SBSdk/07;SBSdw2/10;SBSmc2/10;SBSmc3/08;SBSmh/09;SBSmk1/09;SBSmk2/06;SBSmm/08;SBSmw/09;SBSvk/06;SBSwk1/09;SBSwk2/06;SBSwk3/08	Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Coniferous - moist/wet
Picea engelmannii x *glauca / Oplopanax horridus*	hybrid white spruce / devil's club	S4	Yellow		ICHvc/03;ICHvc/04;ICHwc/05;SBSmc2/09;SBSmk1/08;SBSmw/08;SBSvk/01;SBSwk1/08;SBSwk2/05;SBSwk3/07;SBSwk3a/07	Terrestrial - Forest: Coniferous - moist/wet
Picea sitchensis - Thuja plicata / Oplopanax horridus	Sitka spruce - western redcedar / devil's club	S4	Yellow		CWHwm/04	Terrestrial - Forest: Coniferous - moist/wet
Picea sitchensis - Tsuga heterophylla / Gymnocarpium dryopteris	Sitka spruce - western hemlock / oak fern	S3S4	Yellow		CWHwm/03	Terrestrial - Forest: Coniferous - mesic
Picea sitchensis / Lysichiton americanus	Sitka spruce / skunk cabbage	S3	Blue		CWHwm/09	Terrestrial - Forest: Coniferous - moist/wet;Wetland - Mineral: Wetland Swamp (Ws)
Picea sitchensis / Rubus spectabilis Wet Maritime	Sitka spruce / salmonberry Wet Maritime	S3	Blue		CWHwm/05	Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Mixed - moist/wet
Pinus contorta / Sphagnum spp.	lodgepole pine / peat-mosses	S4S5	Yellow		CWHdm/11;CWHds1/11;CWHds2/11;CWHmm1/11;CWHms1/10;CWHms2/10;CWHvm1/13;CWHwm/10;CWHws1/10	Wetland - Peatland: Wetland Bog (Wb)
Plantago maritima - Puccinellia pumila	sea plantain - dwarf alkaligrass	S2	Red		CWH/Em04	Estuarine: Estuary Marsh (Em)
Populus trichocarpa - Abies lasiocarpa / Oplopanax horridus	black cottonwood - subalpine fir / devil's club	S2S3	Blue		ICHmc1/Fm03;ICHmc2/Fm03;ICHvc/Fm03;ICHwc/06;ICHwc/Fm03;SBSvk/Fm03	Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet
Populus trichocarpa - Alnus rubra / Rubus spectabilis	black cottonwood - red alder / salmonberry	S3	Blue		CDFmm/08;CWHdm/09;CWHds1/09;CWHds2/09;CWHmm1/09;CWHms1/08;CWHms2/08;CWHvm1/10;CWHwm/06;CWHws1/08;CWHws2/08;CWHxm1/09;CWHxm2/09	Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet
Ruppia maritima Herbaceous Vegetation	beaked ditch-grass Herbaceous Vegetation	S2	Red		CDFmm/Em01;CWH/Em01	Estuarine: Estuary Marsh (Em)
Salix sitchensis - Salix lasiandra var. *lasiandra / Lysichiton americanus*	Sitka willow - Pacific willow / skunk cabbage	S2	Red		CDFmm/Ws51;CWH/Ws51;ICH/Ws51	Wetland - Mineral: Wetland Swamp (Ws)

Scientific Name	English Name	Prov Status	BC List	Identified Wildlife	Biogeoclimatic Units	Ecosystem Group
Tsuga heterophylla - Picea sitchensis / Hylocomium splendens	western hemlock - Sitka spruce / step moss	S3	Blue		CWHwm/02	Terrestrial - Forest: Coniferous - dry
Tsuga heterophylla - Picea sitchensis / Vaccinium alaskaense	western hemlock - Sitka spruce / Alaskan blueberry	S4	Yellow		CWHwm/01	Terrestrial - Forest: Coniferous - mesic
Tsuga heterophylla - Picea x lutzii / Hylocomium splendens	western hemlock - Roche spruce / step moss	S4S5	Yellow		ICHmc1/01;ICHmc2/01;ICHvc/02;ICHwc/03	Terrestrial - Forest: Coniferous - mesic;Terrestrial - Forest: Mixed - dry
Tsuga heterophylla / Oplopanax horridus	western hemlock / devil's club	S4	Yellow		ICHvc/01;ICHwc/04	Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Coniferous - moist/wet
Tsuga heterophylla / Rubus chamaemorus / Sphagnum spp.	western hemlock / cloudberry / peat-mosses	S2	Red		ICHmc2/Wb04;ICHvc/Wb04;ICHwc/Wb04	Wetland - Peatland: Wetland Bog (Wb)
Tsuga heterophylla / Sphagnum girgensohnii	western hemlock / common green peat-moss	S3	Blue		CWHwm/08	Terrestrial - Forest: Coniferous - moist/wet
Tsuga mertensiana - Abies amabilis / Phyllodoce empetriformis Moist Maritime 1	mountain hemlock - amabilis fir / pink mountain-heather Moist Maritime 1	S4	Yellow		MHmm1/02	Terrestrial - Forest: Coniferous - dry
Tsuga mertensiana - Abies amabilis / Phyllodoce empetriformis Moist Maritime 2	mountain hemlock - amabilis fir / pink mountain-heather Moist Maritime 2	S4	Yellow		MHmm2/02	Terrestrial - Forest: Coniferous - dry
Tsuga mertensiana - Abies amabilis / Rubus pedatus	mountain hemlock - amabilis fir / five-leaved bramble	S4S5	Yellow		MHmm1/04;MHmm2/04	Terrestrial - Forest: Coniferous - moist/wet
Tsuga mertensiana - Abies amabilis / Vaccinium alaskaense	mountain hemlock - amabilis fir / Alaskan blueberry	S3S4	Yellow		MHmm1/01;MHmm2/01	Terrestrial - Forest: Coniferous - mesic
Tsuga mertensiana - Xanthocyparis nootkatensis / Blechnum spicant	mountain hemlock - yellow-cedar / deer fern	S4	Yellow		MHmm1/06;MHmm2/06;MHwh/06;MHwh1/06	Terrestrial - Forest: Coniferous - moist/wet
Tsuga mertensiana - Xanthocyparis nootkatensis / Sphagnum capillifolium	mountain hemlock - yellow-cedar / common red peat-moss	S5	Yellow		MHmm1/08;MHmm2/08;MHwh/08;MHwh1/08	Wetland - Peatland: Wetland Bog (Wb)
Xanthocyparis nootkatensis - Tsuga mertensiana / Lysichiton americanus	yellow-cedar - mountain hemlock / skunk cabbage	S4	Yellow		MHmm1/09;MHmm2/09;MHwh/09;MHwh1/09	Terrestrial - Forest: Coniferous - moist/wet;Wetland - Mineral: Wetland Swamp (Ws)
Xanthocyparis nootkatensis - Tsuga mertensiana / Veratrum viride	yellow-cedar - mountain hemlock / Indian hellebore	S4	Yellow		MHmm1/07;MHmm2/07;MHwh/07;MHwh1/07	Terrestrial - Forest: Coniferous - moist/wet

APPENDIX G. SUMMARY OF SOILS FIELD SAMPLE DATA

Appendix G. Summary of Soils Field Sample Data

Plot	Texture_1	Surf_Material_1	Surf_Exp_1	Geo_Process_1	Texture_2	Surf_Material_2	Surf_Exp_2	Soil_Class
001	X	D	X	-				DYB
002	d	m	b	-				ODYB
003	d	M	b	-				ODYB
004	p	m	b	-				ODYB
005	p	m	b	-				
006	d	C	b	F				ODYB/ OHFP
007	d	m	b	-				OHFP
009	-	R	u	-				none
010	v	R	u	-				
011	d	C	u	-				ODYB
012	x	m	b	-				ODYB
013	x	C	b	F				ODYB
014	u	O	b	L				TYM
015	u	O	b	L				-
016	g	F	P	I				CU.R
017	SZ	C	u	S	x	D		O.EB
018	g	m	b	-				O.HR
019	g	C	b	L				O.R
020	KpS	F	F	-				FDYR
021	bp	C	b	V		F	p	
022	S	F	P	I				
023	X	C	X	L		R	n	O.R
024	ab	C	V	-		R		
026	e	O	V	L		F	f	T.F
027	U	O	b	L				TY.M
028	Zsg	M	v	-		R		
029	U	P	b	L				TE.M
030a	Sg	M	V	-		D		
030b	Szg	C	b	S				O.EB
031	X	C	f	-				O.R
032	g	F	p	-				E.DYB
RD001	Zsg	F	p					
RD002	szX	C	K					
RD003	zs	F	P					
RD004		F	P					
RD005	sg	F	P					
RD006	zs	L	P					
RD007	z	F	P					
RD008	z	C	sb					
RD009		C	K					
RD010	zs	Fl	P					
RD011	z	L	d					
RD012		L	d					
RD013	zs	F	P					

Appendix G. Summary of Soils Field Sample Data

Plot	Humus	Hydrogeo	Root _Depth	RZ_Part_ Size	Restrict_ Depth	Restrict_ Type	Water_S ource	Seepage	Drainage	Flood_Reg
001	HR		32	CLS	32	R	SP	-	W	X
002	-		19	FSI	-	N	PS	-	w	-
003	-		13	CSI	17	K	PS	-	m	-
004	RD		18	-	-	-	P	-	w	-
005									Well	
006	R		28	FSI	-	-	P	-	VW	-
007	HR		60	FSL	30	K	P	-	w	-
009	none		surface	-	0	L	P	-	-	-
010								-	R	
011	-		20	F	-	-	PS	-	VW	-
012	-		28	CLS	-	-	P	-	w	-
013	-		25	F	-	-	P	-	VW	-
014	-	P.ob	30	-	-	-	PG	54	ppa	A
015	-								P	
016	RD	F	-	-	-	-	-	-	-	-
017	-	-	36	FL	-	-	P	-	w	-
018	-	-	25	SS	-	-	PG	-	w	-
019	TD				-	-		-	W	
020	TD	-	50	SS	-	-	PG	-	I	-
021	-									
022	-								W	
023	RD	U	-	-	6	R	-	-	-	-
024									R	
026	-	P.oh	25	-	?	W	PG	0	VP	E
027	-	P.lh	25	-	20	W	PG	20	P	E
028									W	
029									Poorly	
030a	Mor				35	D				
030b	Mor	-	22	FL	-	-	P	-	W	-
031	-	-	-	-	-	-	-	-	-	-
032	RD	F.a	40	FL	-	-	P	-	W	-
RD001									W	
RD002									R	
RD003									I	
RD004									W	
RD005									R	
RD006									P	
RD007									-	
RD008									M	
RD009									R	
RD010									I	
RD011									V	
RD012									V	
RD013									P	

APPENDIX H. CARO ANALYTICAL SERVICES CERTIFICATE OF ANALYSIS

CERTIFICATE OF ANALYSIS

REPORTED TO	EcoLogic 252 - 1st Street, East North Vancouver, BC V7L 1B3	**TEL** **FAX**	(604) 836-2273 -
ATTENTION	Daniel McAllister	**WORK ORDER**	7011325
PO NUMBER		**RECEIVED / TEMP**	2017-01-18 13:15 / 11°C
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09
PROJECT INFO	TEM soils		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Particle Size Analysis:

All soil samples were sived on 2 mm sieve . The portion that was < 2mm was analyzed by hydrometer and seperate as sand, silt and clay fraction.The % of these fractions were proportional back to the whole sample.

<Original signed by>

Authorized By: **Bryan Shaw, Ph.D., P.Chem.**
Account Manager

If you have any questions or concerns, please contact me at bshaw@caro.ca

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REPORTED TO	EcoLogic	**WORK ORDER**	7011325
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ANALYSIS INFORMATION

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analysis Description	Method Reference	Technique	Location
Calcium Carbonate Equivalence in Soil	Custom	N/A	Richmond
Carbon, Total Organic in Soil	Carter 21.2	Catalytic Combustion and Infrared Detection	Kelowna
Metals in Sat. Paste Extract by ICPMS in Soil	EPA 6020A	Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Metals in Tissue by ICPMS in Tissue (dry)	EPA 200.3 / EPA 6020A	HNO3+HCl+H2O2 Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Moisture in Tissue (dry)	ASTM D2974-87*	Gravimetry (Dried at 105C)	N/A
Particle Size (Sand/Silt/Clay) in Soil	Carter 55.3	Hydrometer Method	Richmond
Particle Size by Dry Sieve in Soil	N/A	N/A	Richmond
SALM by ICPMS in Soil	BCMOE SALM V.2 / EPA 6020A	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Saturated Paste Conductivity in Soil	APHA 2510 B	Conductivity Meter	Richmond
Saturated Paste pH in Soil	APHA 4500-H+ B	Electrometry	Richmond
Sodium Adsorption Ratio (Calc) in Soil	Carter 15.4.4	Calculation (based on the concentration of Na/Ca/Mg in Sat. Paste extract)	N/A

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
ASTM	ASTM International Test Methods
Carter	Soil Sampling and Methods of Analysis, 2nd Edition (2007), Carter/Gregorich
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
%	Percent
% dry	Percent (dry weight)
% wet	Percent (wet weight)
ds/m	Decisiemens per metre
meq/L	Milliequivalents per litre
mg/kg dry	Milligrams per kilogram (dry weight)
mg/L	Milligrams per litre
pH units	pH < 7 = acidic, ph > 7 = basic

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: V33 (leaf) (7011325-01) [Tissue (dry)] Sampled: 2016-07-01 00:00						
General Parameters						
Moisture	**63.4**	0.1	% wet	N/A	2017-02-08	
Metals in Tissue						
Aluminum	**149**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.080**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**1.03**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**44.1**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	**0.007**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**7.0**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**7.25**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**24300**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.68**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**1.32**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**11.6**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**381**	1	mg/kg dry	2017-02-02	2017-02-07	
Lead	**0.378**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**2870**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**402**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.010**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.20**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**13.3**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**1900**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**12500**	10	mg/kg dry	2017-02-02	2017-02-07	
Selenium	**1.35**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	**0.02**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**39**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**101**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	**0.002**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	**0.03**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**4.64**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	**0.004**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Vanadium	**0.46**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**355**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Sample ID: 023 (leaf) (7011325-02) [Tissue (dry)] Sampled: 2016-07-08 00:00						
General Parameters						
Moisture	**67.9**	0.1	% wet	N/A	2017-02-08	
Metals in Tissue						
Aluminum	**65.3**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.032**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**0.379**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**18.7**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	**0.002**	0.002	mg/kg dry	2017-02-02	2017-02-07	

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PROJECT Red Mountain Baseline

WORK ORDER 7011325
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Sample ID: 023 (leaf) (7011325-02) [Tissue (dry)] Sampled: 2016-07-08 00:00, Continued

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Metals in Tissue, Continued						
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**25.3**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**3.32**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**17100**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.30**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**0.373**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**8.47**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**205**	1	mg/kg dry	2017-02-02	2017-02-07	
Lead	**0.149**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**2590**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**70.8**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.013**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.45**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**5.55**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**2870**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**21000**	10	mg/kg dry	2017-02-02	2017-02-07	
Selenium	**3.12**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	< 0.01	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**26**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**58.0**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	< 0.001	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	**0.02**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**2.26**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	**0.003**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Vanadium	**0.20**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**158**	0.1	mg/kg dry	2017-02-02	2017-02-07	

Sample ID: V38 (leaf) (7011325-03) [Tissue (dry)] Sampled: 2016-07-22 00:00

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
General Parameters						
Moisture	**69.3**	0.1	% wet	N/A	2017-02-08	
Metals in Tissue						
Aluminum	**11.8**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.006**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**0.060**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**72.2**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	< 0.002	0.002	mg/kg dry	2017-02-02	2017-02-07	
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**38.8**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**2.90**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**20000**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.17**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**0.370**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**17.8**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**90**	1	mg/kg dry	2017-02-02	2017-02-07	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: V38 (leaf) (7011325-03) [Tissue (dry)] Sampled: 2016-07-22 00:00, Continued

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Metals in Tissue, Continued						
Lead	**0.038**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**3230**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**158**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.006**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.45**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**2.58**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**4510**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**15300**	10	mg/kg dry	2017-02-02	2017-02-07	
Selenium	**0.16**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	< 0.01	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**20**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**67.1**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	< 0.001	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**0.53**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	< 0.001	0.001	mg/kg dry	2017-02-02	2017-02-07	
Vanadium	**0.04**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**124**	0.1	mg/kg dry	2017-02-02	2017-02-07	

Sample ID: V36 (leaf) (7011325-04) [Tissue (dry)] Sampled: 2016-07-10 00:00

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
General Parameters						
Moisture	**70.3**	0.1	% wet	N/A	2017-02-08	
Metals in Tissue						
Aluminum	**21.1**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.012**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**0.071**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**99.3**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	< 0.002	0.002	mg/kg dry	2017-02-02	2017-02-07	
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**58.3**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**2.50**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**22300**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.16**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**0.506**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**9.53**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**89**	1	mg/kg dry	2017-02-02	2017-02-07	
Lead	**0.091**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**3680**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**230**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.009**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.22**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**0.63**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**4700**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**19000**	10	mg/kg dry	2017-02-02	2017-02-07	

SAMPLE ANALYTICAL DATA

CARO ANALYTICAL SERVICES

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: V36 (leaf) (7011325-04) [Tissue (dry)] Sampled: 2016-07-10 00:00, Continued						
Metals in Tissue, Continued						
Selenium	**0.09**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	< 0.01	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**18**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**78.5**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	**0.002**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**0.94**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	< 0.001	0.001	mg/kg dry	2017-02-02	2017-02-07	
Vanadium	**0.07**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**143**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Sample ID: 026 (leaf) (7011325-05) [Tissue (dry)] Sampled: 2016-07-09 00:00						
General Parameters						
Moisture	**65.9**	0.1	% wet	N/A	2017-02-08	
Metals in Tissue						
Aluminum	**84.8**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.042**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**0.963**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**6.28**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	**0.003**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**28.1**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**0.639**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**25600**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.35**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**1.26**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**2.99**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**247**	1	mg/kg dry	2017-02-02	2017-02-07	
Lead	**0.193**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**4800**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**692**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.010**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.14**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**0.84**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**2760**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**13500**	10	mg/kg dry	2017-02-02	2017-02-07	
Selenium	**0.85**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	< 0.01	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**34**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**113**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	**0.001**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**4.22**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	**0.003**	0.001	mg/kg dry	2017-02-02	2017-02-07	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: 026 (leaf) (7011325-05) [Tissue (dry)] Sampled: 2016-07-09 00:00, Continued						
Metals in Tissue, Continued						
Vanadium	**0.27**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**43.0**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Sample ID: 1 (leaf) (7011325-06) [Tissue (dry)] Sampled: 2016-07-04 00:00						
General Parameters						
Moisture	**62.9**	0.1	% wet	N/A	2017-02-08	
Metals in Tissue						
Aluminum	**75.6**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.034**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**0.364**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**16.9**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	**0.003**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**22.0**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**4.25**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**16700**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.39**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**0.937**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**12.9**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**226**	1	mg/kg dry	2017-02-02	2017-02-07	
Lead	**0.167**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**3480**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**240**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.011**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.42**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**8.29**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**3110**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**15400**	10	mg/kg dry	2017-02-02	2017-02-07	
Selenium	**0.90**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	< 0.01	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**29**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**55.9**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	**0.002**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**2.83**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	**0.003**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Vanadium	**0.29**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**212**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Sample ID: Plot 22 (leaf) (7011325-07) [Tissue (dry)] Sampled: 2016-07-08 00:00						
General Parameters						
Moisture	**71.6**	0.1	% wet	N/A	2017-02-08	

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Plot 22 (leaf) (7011325-07) [Tissue (dry)] Sampled: 2016-07-08 00:00, Continued						
Metals in Tissue						
Aluminum	**25.3**	0.4	mg/kg dry	2017-02-02	2017-02-07	
Antimony	**0.010**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Arsenic	**0.179**	0.005	mg/kg dry	2017-02-02	2017-02-07	
Barium	**24.0**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Beryllium	< 0.002	0.002	mg/kg dry	2017-02-02	2017-02-07	
Bismuth	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Boron	**50.7**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Cadmium	**6.31**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Calcium	**23000**	2	mg/kg dry	2017-02-02	2017-02-07	
Chromium	**0.20**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Cobalt	**0.398**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Copper	**11.6**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Iron	**108**	1	mg/kg dry	2017-02-02	2017-02-07	
Lead	**0.067**	0.004	mg/kg dry	2017-02-02	2017-02-07	
Magnesium	**2330**	2	mg/kg dry	2017-02-02	2017-02-07	
Manganese	**140**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Mercury	**0.019**	0.002	mg/kg dry	2017-02-02	2017-02-07	
Molybdenum	**0.40**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Nickel	**3.35**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Phosphorus	**3500**	5	mg/kg dry	2017-02-02	2017-02-07	
Potassium	**22900**	10	mg/kg dry	2017-02-02	2017-02-07	
Selenium	**4.52**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Silver	< 0.01	0.01	mg/kg dry	2017-02-02	2017-02-07	
Sodium	**31**	2	mg/kg dry	2017-02-02	2017-02-07	
Strontium	**74.8**	0.01	mg/kg dry	2017-02-02	2017-02-07	
Thallium	**0.002**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Tin	< 0.02	0.02	mg/kg dry	2017-02-02	2017-02-07	
Titanium	**1.04**	0.05	mg/kg dry	2017-02-02	2017-02-07	
Uranium	**0.005**	0.001	mg/kg dry	2017-02-02	2017-02-07	
Vanadium	**0.08**	0.02	mg/kg dry	2017-02-02	2017-02-07	
Zinc	**163**	0.1	mg/kg dry	2017-02-02	2017-02-07	
Sample ID: 001 0-15 cm (soil) (7011325-08) [Soil] Sampled: 2016-07-04 00:00						
General Parameters						
Calcium Carbonate Equivalence	**1.5**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**7.65**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.0**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.6**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	**5.6**	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	**0.3**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**2.1**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: 001 0-15 cm (soil) (7011325-08) [Soil] Sampled: 2016-07-04 00:00, Continued						
Salinity Parameters (Sat. Paste Extract), Continued						
Potassium, Saturated Paste	**2.6**	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	**0.07**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**7.0**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.3**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**41.4**	0.1	%	N/A	2017-02-06	
Sand	**40**	2	% dry	N/A	2017-02-07	HT1
Silt	< 2	2	% dry	N/A	2017-02-07	HT1
Clay	**17**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**3.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**59.4**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**91**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.6**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**0.42**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**21.6**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**11.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**85.9**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**23.0**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.07**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**9.6**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**18.0**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	**2.2**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	**0.5**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.7**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.74**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**78.9**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**120**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: V24 0-15 (soil) (7011325-09) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**0.5**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**3.22**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.0**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.4**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	**8.0**	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	**0.4**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**1.8**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.1**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**2.7**	0.4	mg/L	2017-02-06	2017-02-06	

SAMPLE ANALYTICAL DATA

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: V24 0-15 (soil) (7011325-09) [Soil] Sampled: 2016-07-08 00:00, Continued						
Salinity Parameters (Sat. Paste Extract), Continued						
Potassium, Saturated Paste	**0.07**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**4.4**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**26.2**	0.1	%	N/A	2017-02-06	
Sand	**55**	2	% dry	N/A	2017-02-07	HT1
Silt	**4**	2	% dry	N/A	2017-02-07	HT1
Clay	**15**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**7.4**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**36.1**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**70**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.9**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**0.17**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**8.3**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**20.1**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**90.0**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**16.4**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.05**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**9.5**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**31.8**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	**1.4**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	< 0.2	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.2**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.44**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**33.3**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**36**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: 30 0-15 (soil) (7011325-10) [Soil] Sampled: 2016-07-09 00:00						
General Parameters						
Calcium Carbonate Equivalence	**2.8**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**4.04**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**4.8**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	**0.16**	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**1.4**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	< 4.0	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	< 0.2	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**2.0**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**3.0**	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	**0.08**	0.01	meq/L	N/A	N/A	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: 30 0-15 (soil) (7011325-10) [Soil] Sampled: 2016-07-09 00:00, Continued						
Salinity Parameters (Sat. Paste Extract), Continued						
Sodium, Saturated Paste	**10.8**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.5**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**41.2**	0.1	%	N/A	2017-02-06	
Sand	**41**	2	% dry	N/A	2017-02-07	HT1
Silt	**4**	2	% dry	N/A	2017-02-07	HT1
Clay	**14**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**4.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**30.0**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**79**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.4**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**0.16**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**22.8**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**23.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**104**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**34.3**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.08**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**12.5**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**36.9**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	**1.8**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	**0.4**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.4**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.5**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.51**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**81.8**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**48**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: FS882 Plot 32 0-15 (soil) (7011325-11) [Soil] Sampled: 2016-07-10 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.0**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**1.29**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.5**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	**0.93**	0.10	dS/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.2**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	**124**	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	**6.2**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**26.1**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**2.1**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**8.2**	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	**0.2**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**8.5**	0.4	mg/L	2017-02-06	2017-02-06	

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FS882 Plot 32 0-15 (soil) (7011325-11) [Soil] Sampled: 2016-07-10 00:00, Continued						
Salinity Parameters (Sat. Paste Extract), Continued						
Sodium, Saturated Paste	**0.4**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**5.9**	0.1	%	N/A	2017-02-06	
Sand	**69**	2	% dry	N/A	2017-02-07	HT1
Silt	**7**	2	% dry	N/A	2017-02-07	HT1
Clay	**19**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**5.6**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**32.2**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**181**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.5**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**1.36**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**16.8**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**17.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**86.0**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**42.7**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.05**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**7.0**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**43.8**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	**2.2**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	**1.0**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	< 0.2	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.53**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**45.1**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**132**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: 012 0-15 (soil) (7011325-12) [Soil] Sampled: 2016-07-06 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.4**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**4.35**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.2**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.1**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	< 4.0	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	< 0.2	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**0.9**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.07**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	< 0.4	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	< 0.01	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.0**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.05**	0.02	meq/L	N/A	N/A	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: 012 0-15 (soil) (7011325-12) [Soil] Sampled: 2016-07-06 00:00, Continued						
Particle Size Distribution						
> 2.0 mm	**34.2**	0.1	%	N/A	2017-02-06	
Sand	**46**	2	% dry	N/A	2017-02-07	HT1
Silt	**3**	2	% dry	N/A	2017-02-07	HT1
Clay	**16**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**1.8**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**22.3**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**126**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.5**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**1.13**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**20.0**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**14.6**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**26.2**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**42.4**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.08**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**1.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**15.0**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	< 0.5	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	< 0.2	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.3**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.49**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**65.0**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**242**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: 011 0-15 (soil) (7011325-13) [Soil] Sampled: 2016-07-06 00:00						
General Parameters						
Calcium Carbonate Equivalence	**2.3**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**1.58**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.0**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.4**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	< 4.0	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	< 0.2	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**1.4**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.1**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**3.3**	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	**0.09**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**2.6**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.1**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**51.8**	0.1	%	N/A	2017-02-06	

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: 011 0-15 (soil) (7011325-13) [Soil] Sampled: 2016-07-06 00:00, Continued						
Particle Size Distribution, Continued						
Sand	**44**	2	% dry	N/A	2017-02-07	HT1
Silt	< 2	2	% dry	N/A	2017-02-07	HT1
Clay	**3**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**4.0**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**73.6**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**54**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**0.45**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**29.0**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**13.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**194**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**22.5**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	< 0.04	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**32.6**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**30.3**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	**3.2**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	**0.5**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	< 0.1	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.3**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**1.18**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**99.3**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**138**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: V21 0-15 (soil) (7011325-14) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**2.9**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**3.58**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.0**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	**0.14**	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.4**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	**8.2**	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	**0.4**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**4.4**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.4**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**2.3**	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	**0.06**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**5.5**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**42.4**	0.1	%	N/A	2017-02-06	
Sand	**47**	2	% dry	N/A	2017-02-07	HT1

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: V21 0-15 (soil) (7011325-14) [Soil] Sampled: 2016-07-08 00:00, Continued						
Particle Size Distribution, Continued						
Silt	**3**	2	% dry	N/A	2017-02-07	HT1
Clay	**8**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**3.0**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**25.0**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**114**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.5**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**0.36**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**30.6**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**17.9**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**85.2**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**11.8**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.06**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**4.7**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**50.4**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Selenium	**3.0**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	< 0.2	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.1**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.3**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.32**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**70.8**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**93**	2	mg/kg dry	2017-02-06	2017-02-06	
Sample ID: RW 196 (soil) (7011325-15) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.3**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**1.97**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.0**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.41**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	**0.1**	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**40.9**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**2.0**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**10.7**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.9**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**8.5**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.2**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**3.3**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.1**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**38.0**	0.1	%	N/A	2017-01-30	HT1
Sand	**47**	2	% dry	N/A	2017-02-09	HT1
Silt	**4**	2	% dry	N/A	2017-02-09	HT1

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: RW 196 (soil) (7011325-15) [Soil] Sampled: 2016-07-08 00:00, Continued						
Particle Size Distribution, Continued						
Clay	**11**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**28.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**107**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.50**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**25.7**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**12.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**66.1**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**17.0**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	**0.07**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**2.7**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**21.4**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**0.9**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.7**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	**0.2**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.77**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**67.8**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**85**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: EL RY 3RW2 (soil) (7011325-16) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**4.0**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.23**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.1**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.14**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	**0.1**	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**16.9**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**0.8**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**3.7**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.3**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**2.8**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.07**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.3**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.06**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**69.2**	0.1	%	N/A	2017-01-30	HT1
Sand	**30**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	< 2	2	% dry	N/A	2017-02-09	HT1

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: EL RY 3RW2 (soil) (7011325-16) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals						
Antimony	**3.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**42.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**65**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.45**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**16.8**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**7.7**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**69.6**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**15.4**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**12.0**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**17.4**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**3.9**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.6**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	< 0.1	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**1.06**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**70.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**90**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: EL RY1 RW2 (soil) (7011325-17) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.5**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.31**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.6**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	**0.1**	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**4.4**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**0.2**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**1.5**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.1**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**2.7**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.07**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.3**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.06**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**80.6**	0.1	%	N/A	2017-01-30	HT1
Sand	**16**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	**3**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**1.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: EL RY1 RW2 (soil) (7011325-17) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Arsenic	**21.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**316**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.62**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**13.6**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**10.9**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**107**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**9.6**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**27.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**15.3**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**2.7**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.5**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	< 0.1	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.60**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**68.7**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**102**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: OEL Borrow 1 (soil) (7011325-18) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**6.0**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.74**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**8.0**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.31**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**71.2**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**3.6**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**2.8**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**4.3**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.1**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**0.7**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.03**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**50.7**	0.1	%	N/A	2017-01-30	HT1
Sand	**35**	2	% dry	N/A	2017-02-09	HT1
Silt	**5**	2	% dry	N/A	2017-02-09	HT1
Clay	**9**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**1.9**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**20.8**	0.4	mg/kg dry	2017-01-27	2017-01-27	

REPORTED TO EcoLogic
PROJECT Red Mountain Baseline

WORK ORDER 7011325
REPORTED 2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: OEL Borrow 1 (soil) (7011325-18) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Barium	**157**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.3**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.78**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**79.2**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**15.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**56.6**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**12.8**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**2.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**50.1**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**1.2**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.5**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	< 0.1	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	**0.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**1.22**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**74.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**89**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: 534 RW/RW2 (soil) (7011325-19) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.5**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.41**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**7.6**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.39**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**73.4**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**3.7**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**3.5**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.3**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**10.9**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.3**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	< 0.4	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	< 0.02	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**52.5**	0.1	%	N/A	2017-01-30	HT1
Sand	**46**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	< 2	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.3**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**16.3**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**90**	1	mg/kg dry	2017-01-27	2017-01-27	

REPORTED TO EcoLogic
PROJECT Red Mountain Baseline

WORK ORDER 7011325
REPORTED 2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: 534 RW/RW2 (soil) (7011325-19) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Beryllium	**0.3**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.64**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**67.2**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**10.7**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**59.7**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**8.7**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**5.0**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**39.8**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**1.8**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.5**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	< 0.1	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.46**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**60.3**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**74**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: Borrow A (soil) (7011325-20) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.0**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**2.04**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.7**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.41**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**54.4**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**2.7**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**12.5**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**1.0**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**7.4**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.2**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.1**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.05**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**92.6**	0.1	%	N/A	2017-01-30	HT1
Sand	**6**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	< 2	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**1.8**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**14.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**247**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.6**	0.1	mg/kg dry	2017-01-27	2017-01-27	

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Borrow A (soil) (7011325-20) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Cadmium	**0.38**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**33.3**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**18.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**72.0**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**16.8**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	**0.07**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**1.8**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**18.8**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	< 0.5	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.4**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	**0.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.39**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**95.9**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**82**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: RW 38 (soil) (7011325-21) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**3.5**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.84**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**4.9**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.12**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	**0.2**	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**10.3**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**0.5**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**5.9**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.5**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**13.7**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.4**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**2.7**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.1**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**75.3**	0.1	%	N/A	2017-01-30	HT1
Sand	**20**	2	% dry	N/A	2017-02-09	HT1
Silt	**4**	2	% dry	N/A	2017-02-09	HT1
Clay	< 2	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**4.7**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**60.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**141**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.68**	0.04	mg/kg dry	2017-01-27	2017-01-27	

SAMPLE ANALYTICAL DATA

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: RW 38 (soil) (7011325-21) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Chromium	**21.3**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**9.8**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**99.1**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**28.5**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	**0.04**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**15.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**22.2**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**4.7**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**1.0**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	**0.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**1.92**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**89.2**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**114**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: KL113 (soil) (7011325-22) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**4.0**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**1.58**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**7.4**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**1.02**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**210**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**10.5**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**6.0**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.5**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**5.8**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.1**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**0.4**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.02**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**28.8**	0.1	%	N/A	2017-01-30	HT1
Sand	**50**	2	% dry	N/A	2017-02-09	HT1
Silt	**4**	2	% dry	N/A	2017-02-09	HT1
Clay	**17**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.6**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**124**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**176**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.86**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**22.4**	1.0	mg/kg dry	2017-01-27	2017-01-27	

SAMPLE ANALYTICAL DATA

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: KL113 (soil) (7011325-22) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Cobalt	**13.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**69.9**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**18.8**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**2.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**30.2**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**2.4**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.6**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	**0.2**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.50**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**61.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**96**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: Radio EL 5 RW2 (7011325-23) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**1.5**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**1.62**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.3**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	**0.2**	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	< 4.0	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	< 0.2	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**2.3**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**8.0**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.2**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.5**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.07**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**69.6**	0.1	%	N/A	2017-01-30	HT1
Sand	**26**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	**4**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**3.8**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**23.9**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**87**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.43**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**18.0**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**15.2**	0.1	mg/kg dry	2017-01-27	2017-01-27	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Radio EL 5 RW2 (7011325-23) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Copper	**79.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**26.1**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	**0.06**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**3.9**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**39.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**1.8**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.6**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.38**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**46.9**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**86**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: RW 114 (soil) (7011325-24) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**4.0**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.54**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**7.8**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.77**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**167**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**8.3**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**8.9**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.7**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**12.4**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.3**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**0.9**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.04**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**43.2**	0.1	%	N/A	2017-01-30	HT1
Sand	**46**	2	% dry	N/A	2017-02-09	HT1
Silt	**3**	2	% dry	N/A	2017-02-09	HT1
Clay	**8**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.6**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**24.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**91**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.3**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**1.02**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**55.3**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**12.7**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**60.4**	0.2	mg/kg dry	2017-01-27	2017-01-27	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: RW 114 (soil) (7011325-24) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Lead	**12.5**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	**0.04**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**5.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**46.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**3.1**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.7**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.56**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**59.9**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**98**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: RW 78 (soil) (7011325-25) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**2.5**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.43**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**8.0**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.53**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**113**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**5.6**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**3.0**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.2**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**3.1**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.08**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.0**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.04**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**32.5**	0.1	%	N/A	2017-01-30	HT1
Sand	**36**	2	% dry	N/A	2017-02-09	HT1
Silt	**14**	2	% dry	N/A	2017-02-09	HT1
Clay	**18**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.0**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**19.8**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**142**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.78**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**75.9**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**15.6**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**68.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**10.2**	0.2	mg/kg dry	2017-01-27	2017-01-27	

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Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: RW 78 (soil) (7011325-25) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**4.9**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**55.4**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**1.7**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.5**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	< 0.1	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	**0.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.55**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**83.4**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**83**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: EL RY2 (soil) (7011325-26) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**7.5**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.93**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**7.8**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.39**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**85.4**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**4.3**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**4.0**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.3**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**2.9**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.08**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**0.8**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.04**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**37.4**	0.1	%	N/A	2017-01-30	HT1
Sand	**57**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	**4**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**16.0**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**300**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.56**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**25.9**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**15.6**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**61.9**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**22.0**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	< 0.04	0.04	mg/kg dry	2017-01-27	2017-01-27	

Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: EL RY2 (soil) (7011325-26) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Molybdenum	**1.6**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Nickel	**25.8**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**0.6**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.4**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.36**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**79.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**84**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: RW 92 (soil) (7011325-27) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**5.0**	0.1	% dry	2017-01-31	2017-02-08	
Carbon, Total Organic	**0.40**	0.05	% dry	2017-01-24	2017-01-30	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**7.3**	0.1	pH units	2017-01-31	2017-01-31	
Conductivity, Saturated Paste	**0.73**	0.10	ds/m	2017-01-31	2017-02-01	
Sodium Adsorption Ratio	< 0.1	0.1	-	N/A	2017-02-01	
Calcium, Saturated Paste	**156**	4.0	mg/L	2017-01-31	2017-01-31	
Calcium, Saturated Paste	**7.8**	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**10.2**	0.2	mg/L	2017-01-31	2017-01-31	
Magnesium, Saturated Paste	**0.8**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	**9.5**	0.4	mg/L	2017-01-31	2017-01-31	
Potassium, Saturated Paste	**0.2**	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.5**	0.4	mg/L	2017-01-31	2017-01-31	
Sodium, Saturated Paste	**0.06**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**70.1**	0.1	%	N/A	2017-01-30	HT1
Sand	**24**	2	% dry	N/A	2017-02-09	HT1
Silt	< 2	2	% dry	N/A	2017-02-09	HT1
Clay	**4**	2	% dry	N/A	2017-02-09	HT1
Strong Acid Leachable Metals						
Antimony	**2.4**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Arsenic	**19.9**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Barium	**89**	1	mg/kg dry	2017-01-27	2017-01-27	
Beryllium	**0.3**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Cadmium	**0.81**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Chromium	**67.6**	1.0	mg/kg dry	2017-01-27	2017-01-27	
Cobalt	**14.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Copper	**61.3**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Lead	**11.8**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Mercury	**0.05**	0.04	mg/kg dry	2017-01-27	2017-01-27	
Molybdenum	**4.5**	0.1	mg/kg dry	2017-01-27	2017-01-27	

SAMPLE ANALYTICAL DATA

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Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: RW 92 (soil) (7011325-27) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Nickel	**53.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Selenium	**2.9**	0.5	mg/kg dry	2017-01-27	2017-01-27	
Silver	**0.8**	0.2	mg/kg dry	2017-01-27	2017-01-27	
Thallium	**0.1**	0.1	mg/kg dry	2017-01-27	2017-01-27	
Tin	< 0.2	0.2	mg/kg dry	2017-01-27	2017-01-27	
Uranium	**0.56**	0.05	mg/kg dry	2017-01-27	2017-01-27	
Vanadium	**65.5**	0.4	mg/kg dry	2017-01-27	2017-01-27	
Zinc	**85**	2	mg/kg dry	2017-01-27	2017-01-27	
Sample ID: Rm 001 0-15 (soil) (7011325-28) [Soil] Sampled: 2016-07-08 00:00						
General Parameters						
Calcium Carbonate Equivalence	**1.5**	0.1	% dry	2017-02-07	2017-02-08	
Carbon, Total Organic	**4.38**	0.05	% dry	N/A	2017-02-06	HT1
Salinity Parameters (Sat. Paste Extract)						
pH, Saturated Paste	**5.9**	0.1	pH units	2017-02-08	2017-02-09	
Conductivity, Saturated Paste	< 0.10	0.10	ds/m	2017-02-06	2017-02-06	
Sodium Adsorption Ratio	**0.2**	0.1	-	N/A	2017-02-07	
Calcium, Saturated Paste	< 4.0	4.0	mg/L	2017-02-06	2017-02-06	
Calcium, Saturated Paste	< 0.2	0.2	meq/L	N/A	N/A	
Magnesium, Saturated Paste	**1.0**	0.2	mg/L	2017-02-06	2017-02-06	
Magnesium, Saturated Paste	**0.09**	0.02	meq/L	N/A	N/A	
Potassium, Saturated Paste	< 0.4	0.4	mg/L	2017-02-06	2017-02-06	
Potassium, Saturated Paste	< 0.01	0.01	meq/L	N/A	N/A	
Sodium, Saturated Paste	**1.2**	0.4	mg/L	2017-02-06	2017-02-06	
Sodium, Saturated Paste	**0.05**	0.02	meq/L	N/A	N/A	
Particle Size Distribution						
> 2.0 mm	**23.5**	0.1	%	N/A	2017-02-06	
Sand	**62**	2	% dry	N/A	2017-02-07	HT1
Silt	**4**	2	% dry	N/A	2017-02-07	HT1
Clay	**11**	2	% dry	N/A	2017-02-07	HT1
Strong Acid Leachable Metals						
Antimony	**2.5**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Arsenic	**21.3**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Barium	**55**	1	mg/kg dry	2017-02-06	2017-02-06	
Beryllium	**0.3**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Cadmium	**0.16**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Chromium	**28.3**	1.0	mg/kg dry	2017-02-06	2017-02-06	
Cobalt	**7.9**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Copper	**51.6**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Lead	**12.1**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Mercury	**0.05**	0.04	mg/kg dry	2017-02-06	2017-02-06	
Molybdenum	**4.2**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Nickel	**26.1**	0.4	mg/kg dry	2017-02-06	2017-02-06	

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Analyte	Result / *Recovery*	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: Rm 001 0-15 (soil) (7011325-28) [Soil] Sampled: 2016-07-08 00:00, Continued						
Strong Acid Leachable Metals, Continued						
Selenium	**3.0**	0.5	mg/kg dry	2017-02-06	2017-02-06	
Silver	**1.1**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Thallium	**0.1**	0.1	mg/kg dry	2017-02-06	2017-02-06	
Tin	**0.3**	0.2	mg/kg dry	2017-02-06	2017-02-06	
Uranium	**0.32**	0.05	mg/kg dry	2017-02-06	2017-02-06	
Vanadium	**65.4**	0.4	mg/kg dry	2017-02-06	2017-02-06	
Zinc	**55**	2	mg/kg dry	2017-02-06	2017-02-06	

Sample / Analysis Qualifiers:

HT1 The sample was prepared and/or analyzed past the recommended holding time.

APPENDIX 1: QUALITY CONTROL DATA

CARO ANALYTICAL SERVICES

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B7A1394										
Blank (B7A1394-BLK1)				Prepared: 2017-01-30, Analyzed: 2017-01-30						
Carbon, Total Organic	< 0.05	0.05	% dry							
Duplicate (B7A1394-DUP1)		**Source: 7011325-15**		Prepared: 2017-01-30, Analyzed: 2017-01-30						
Carbon, Total Organic	1.96	0.05	% dry		1.97			< 1	20	
Reference (B7A1394-SRM1)				Prepared: 2017-01-30, Analyzed: 2017-01-30						
Carbon, Total Organic	1.01	0.05	% dry	1.04		97	80-120			
General Parameters, Batch B7A1550										
Blank (B7A1550-BLK1)				Prepared: 2017-01-31, Analyzed: 2017-02-08						
Calcium Carbonate Equivalence	3.0	0.1	% dry							
Duplicate (B7A1550-DUP1)		**Source: 7011325-26**		Prepared: 2017-01-31, Analyzed: 2017-02-08						
Calcium Carbonate Equivalence	7.5	0.1	% dry		7.5			< 1	10	
General Parameters, Batch B7B0270										
Blank (B7B0270-BLK1)				Prepared: 2017-02-06, Analyzed: 2017-02-06						
Carbon, Total Organic	< 0.05	0.05	% dry							
Duplicate (B7B0270-DUP1)		**Source: 7011325-08**		Prepared: 2017-02-06, Analyzed: 2017-02-06						
Carbon, Total Organic	7.35	0.05	% dry		7.65			4	20	
Reference (B7B0270-SRM1)				Prepared: 2017-02-06, Analyzed: 2017-02-06						
Carbon, Total Organic	0.97	0.05	% dry	1.04		94	80-120			
General Parameters, Batch B7B0374										
Blank (B7B0374-BLK1)				Prepared: 2017-02-07, Analyzed: 2017-02-08						
Calcium Carbonate Equivalence	2.1	0.1	% dry							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B7B0374, Continued										
Duplicate (B7B0374-DUP1)		**Source: 7011325-11**		Prepared: 2017-02-07, Analyzed: 2017-02-08						
Calcium Carbonate Equivalence	2.6	0.1	% dry		3.0			14	10	
General Parameters, Batch B7B0443										
Duplicate (B7B0443-DUP1)		**Source: 7011325-03**		Prepared: 2017-02-08, Analyzed: 2017-02-08						
Moisture	69.3	0.1	% wet		69.3			0.0	40	
Metals in Tissue, Batch B7B0139										
Blank (B7B0139-BLK1)				Prepared: 2017-02-02, Analyzed: 2017-02-07						
Aluminum	< 0.4	0.4	mg/kg wet							
Antimony	< 0.002	0.002	mg/kg wet							
Arsenic	< 0.005	0.005	mg/kg wet							
Barium	< 0.01	0.01	mg/kg wet							
Beryllium	< 0.002	0.002	mg/kg wet							
Bismuth	< 0.02	0.02	mg/kg wet							
Boron	< 0.1	0.1	mg/kg wet							
Cadmium	< 0.002	0.002	mg/kg wet							
Calcium	< 2	2	mg/kg wet							
Chromium	< 0.01	0.01	mg/kg wet							
Cobalt	< 0.004	0.004	mg/kg wet							
Copper	< 0.01	0.01	mg/kg wet							
Iron	< 1	1	mg/kg wet							
Lead	< 0.004	0.004	mg/kg wet							
Magnesium	< 2	2	mg/kg wet							
Manganese	< 0.02	0.02	mg/kg wet							
Mercury	< 0.002	0.002	mg/kg wet							
Molybdenum	< 0.01	0.01	mg/kg wet							
Nickel	< 0.01	0.01	mg/kg wet							
Phosphorus	< 5	5	mg/kg wet							
Potassium	< 10	10	mg/kg wet							
Selenium	< 0.02	0.02	mg/kg wet							
Silver	< 0.01	0.01	mg/kg wet							
Sodium	< 2	2	mg/kg wet							
Strontium	< 0.01	0.01	mg/kg wet							
Thallium	< 0.001	0.001	mg/kg wet							
Tin	< 0.02	0.02	mg/kg wet							
Titanium	< 0.05	0.05	mg/kg wet							
Uranium	< 0.001	0.001	mg/kg wet							
Vanadium	< 0.02	0.02	mg/kg wet							
Zinc	< 0.1	0.1	mg/kg wet							
Duplicate (B7B0139-DUP1)		**Source: 7011325-01**		Prepared: 2017-02-02, Analyzed: 2017-02-07						
Aluminum	148	0.4	mg/kg dry		149			< 1	40	
Antimony	0.078	0.002	mg/kg dry		0.080			3	40	
Arsenic	1.01	0.005	mg/kg dry		1.03			2	40	
Barium	41.6	0.01	mg/kg dry		44.1			6	40	
Beryllium	0.006	0.002	mg/kg dry		0.007				40	
Bismuth	< 0.02	0.02	mg/kg dry		< 0.02				40	
Boron	6.9	0.1	mg/kg dry		7.0			1	40	
Cadmium	7.09	0.002	mg/kg dry		7.25			2	40	
Calcium	24600	2	mg/kg dry		24300			1	60	
Chromium	0.66	0.01	mg/kg dry		0.68			3	40	
Cobalt	1.40	0.004	mg/kg dry		1.32			6	40	
Copper	11.8	0.01	mg/kg dry		11.6			1	40	
Iron	374	1	mg/kg dry		381			2	40	

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Metals in Tissue, Batch B7B0139, Continued										
Duplicate (B7B0139-DUP1), Continued		**Source: 7011325-01**		Prepared: 2017-02-02, Analyzed: 2017-02-07						
Lead	0.368	0.004	mg/kg dry		0.378			3	40	
Magnesium	2910	2	mg/kg dry		2870			1	40	
Manganese	371	0.02	mg/kg dry		402			8	40	
Mercury	0.010	0.002	mg/kg dry		0.010			< 1	40	
Molybdenum	0.22	0.01	mg/kg dry		0.20			10	40	
Nickel	13.9	0.01	mg/kg dry		13.3			5	40	
Phosphorus	1940	5	mg/kg dry		1900			2	40	
Potassium	13100	10	mg/kg dry		12500			4	40	
Selenium	1.56	0.02	mg/kg dry		1.35			15	40	
Silver	0.01	0.01	mg/kg dry		0.02				40	
Sodium	42	2	mg/kg dry		39			7	40	
Strontium	102	0.01	mg/kg dry		101			2	60	
Thallium	0.002	0.001	mg/kg dry		0.002				40	
Tin	0.04	0.02	mg/kg dry		0.03				40	
Titanium	4.86	0.05	mg/kg dry		4.64			5	40	
Uranium	0.004	0.001	mg/kg dry		0.004				40	
Vanadium	0.46	0.02	mg/kg dry		0.46			< 1	40	
Zinc	346	0.1	mg/kg dry		355			3	40	
Reference (B7B0139-SRM1)				Prepared: 2017-02-02, Analyzed: 2017-02-07						
Aluminum	97.4	0.4	mg/kg wet	286		34	30-70			
Barium	51.5	0.01	mg/kg wet	49.0		105	80-120			
Boron	30.7	0.1	mg/kg wet	27.0		114	70-130			
Cadmium	0.014	0.002	mg/kg wet	0.0130		107	80-120			
Calcium	15800	2	mg/kg wet	15300		103	70-130			
Chromium	0.11	0.01	mg/kg wet	0.300		38	30-70			
Cobalt	0.079	0.004	mg/kg wet	0.0900		88	80-120			
Copper	5.40	0.01	mg/kg wet	5.64		96	80-120			
Iron	61	1	mg/kg wet	83.0		74	70-130			
Lead	0.358	0.004	mg/kg wet	0.470		76	70-110			
Magnesium	2630	2	mg/kg wet	2710		97	70-130			
Manganese	54.3	0.02	mg/kg wet	54.0		101	80-120			
Mercury	0.043	0.002	mg/kg wet	0.0440		98	70-120			
Molybdenum	0.08	0.01	mg/kg wet	0.0940		89	80-120			
Nickel	0.76	0.01	mg/kg wet	0.910		84	80-120			
Phosphorus	1690	5	mg/kg wet	1590		106	70-130			
Potassium	16500	10	mg/kg wet	16100		102	70-130			
Sodium	33	2	mg/kg wet	24.4		136	90-170			
Strontium	27.3	0.01	mg/kg wet	25.0		109	80-120			
Uranium	0.004	0.001	mg/kg wet	0.00600		72	70-130			
Vanadium	0.11	0.02	mg/kg wet	0.260		43	30-120			
Zinc	11.6	0.1	mg/kg wet	12.5		93	80-120			
Particle Size Distribution, Batch B7B0320										
Duplicate (B7B0320-DUP1)		**Source: 7011325-11**		Prepared: 2017-02-07, Analyzed: 2017-02-07						
Sand	69	2	% dry		69			< 1	30	HT1
Silt	7	2	% dry		7				30	HT1
Clay	19	2	% dry		19			< 1	30	HT1
Salinity Parameters (Sat. Paste Extract), Batch B7A1559										
Reference (B7A1559-SRM1)				Prepared: 2017-01-31, Analyzed: 2017-02-01						
Conductivity, Saturated Paste	12.3	0.10	ds/m	13.3		92	80-120			

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Salinity Parameters (Sat. Paste Extract), Batch B7A1561										
Duplicate (B7A1561-DUP1)		**Source: 7011325-22**			Prepared: 2017-01-31, Analyzed: 2017-01-31					
pH, Saturated Paste	7.4	0.1	pH units		7.4			< 1	10	
Salinity Parameters (Sat. Paste Extract), Batch B7A1570										
Blank (B7A1570-BLK1)					Prepared: 2017-01-31, Analyzed: 2017-01-31					
Calcium, Saturated Paste	< 4.0	4.0	mg/L							
Magnesium, Saturated Paste	< 0.2	0.2	mg/L							
Potassium, Saturated Paste	< 0.4	0.4	mg/L							
Sodium, Saturated Paste	< 0.4	0.4	mg/L							
Duplicate (B7A1570-DUP1)		**Source: 7011325-22**			Prepared: 2017-01-31, Analyzed: 2017-01-31					
Calcium, Saturated Paste	198	4.0	mg/L		210			6	36	
Magnesium, Saturated Paste	5.4	0.2	mg/L		6.0			11	34	
Potassium, Saturated Paste	5.8	0.4	mg/L		5.8			2	27	
Sodium, Saturated Paste	0.5	0.4	mg/L		0.4				24	
Reference (B7A1570-SRM1)					Prepared: 2017-01-31, Analyzed: 2017-01-31					
Calcium, Saturated Paste	259	4.0	mg/L	323		80	80-120			
Magnesium, Saturated Paste	432	0.2	mg/L	543		80	80-120			
Potassium, Saturated Paste	105	0.4	mg/L	115		91	80-120			
Sodium, Saturated Paste	2310	0.4	mg/L	2620		88	80-120			
Salinity Parameters (Sat. Paste Extract), Batch B7B0296										
Blank (B7B0296-BLK1)					Prepared: 2017-02-06, Analyzed: 2017-02-06					
Calcium, Saturated Paste	< 4.0	4.0	mg/L							
Magnesium, Saturated Paste	< 0.2	0.2	mg/L							
Potassium, Saturated Paste	< 0.4	0.4	mg/L							
Sodium, Saturated Paste	< 0.4	0.4	mg/L							
Duplicate (B7B0296-DUP1)		**Source: 7011325-12**			Prepared: 2017-02-06, Analyzed: 2017-02-06					
Calcium, Saturated Paste	< 4.0	4.0	mg/L		< 4.0				36	
Magnesium, Saturated Paste	0.8	0.2	mg/L		0.9				34	
Potassium, Saturated Paste	0.6	0.4	mg/L		< 0.4				27	
Sodium, Saturated Paste	1.2	0.4	mg/L		1.0				24	
Reference (B7B0296-SRM1)					Prepared: 2017-02-06, Analyzed: 2017-02-06					
Calcium, Saturated Paste	225	4.0	mg/L	270		83	80-120			
Magnesium, Saturated Paste	392	0.2	mg/L	426		92	80-120			
Potassium, Saturated Paste	98.1	0.4	mg/L	89.8		109	80-120			
Sodium, Saturated Paste	2040	0.4	mg/L	2060		99	80-120			
Salinity Parameters (Sat. Paste Extract), Batch B7B0306										
Blank (B7B0306-BLK1)					Prepared: 2017-02-06, Analyzed: 2017-02-06					
Conductivity, Saturated Paste	< 0.10	0.10	ds/m							
Reference (B7B0306-SRM1)					Prepared: 2017-02-06, Analyzed: 2017-02-06					
Conductivity, Saturated Paste	11.5	0.10	ds/m	13.3		87	80-120			
Salinity Parameters (Sat. Paste Extract), Batch B7B0469										
Blank (B7B0469-BLK1)					Prepared: 2017-02-08, Analyzed: 2017-02-09					
pH, Saturated Paste	< 0.1	0.1	pH units							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Salinity Parameters (Sat. Paste Extract), Batch B7B0469, Continued										
Duplicate (B7B0469-DUP1)		**Source: 7011325-09**		Prepared: 2017-02-08, Analyzed: 2017-02-09						
pH, Saturated Paste	5.0	0.1	pH units		5.0			< 1	10	
Reference (B7B0469-SRM1)				Prepared: 2017-02-08, Analyzed: 2017-02-09						
pH, Saturated Paste	5.9	0.1	pH units	6.87		86	95-105			SRM
Strong Acid Leachable Metals, Batch B7A1371										
Blank (B7A1371-BLK1)				Prepared: 2017-01-27, Analyzed: 2017-01-27						
Antimony	< 0.1	0.1	mg/kg dry							
Arsenic	< 0.4	0.4	mg/kg dry							
Barium	< 1	1	mg/kg dry							
Beryllium	< 0.1	0.1	mg/kg dry							
Cadmium	< 0.04	0.04	mg/kg dry							
Chromium	< 1.0	1.0	mg/kg dry							
Cobalt	< 0.1	0.1	mg/kg dry							
Copper	< 0.2	0.2	mg/kg dry							
Lead	< 0.2	0.2	mg/kg dry							
Mercury	< 0.04	0.04	mg/kg dry							
Molybdenum	< 0.1	0.1	mg/kg dry							
Nickel	< 0.4	0.4	mg/kg dry							
Selenium	< 0.5	0.5	mg/kg dry							
Silver	< 0.2	0.2	mg/kg dry							
Thallium	< 0.1	0.1	mg/kg dry							
Tin	< 0.2	0.2	mg/kg dry							
Uranium	< 0.05	0.05	mg/kg dry							
Vanadium	< 0.4	0.4	mg/kg dry							
Zinc	< 2	2	mg/kg dry							
Duplicate (B7A1371-DUP1)		**Source: 7011325-27**		Prepared: 2017-01-27, Analyzed: 2017-01-27						
Antimony	2.5	0.1	mg/kg dry		2.4			5	60	
Arsenic	20.2	0.4	mg/kg dry		19.9			2	42	
Barium	94	1	mg/kg dry		89			6	38	
Beryllium	0.3	0.1	mg/kg dry		0.3				37	
Cadmium	0.85	0.04	mg/kg dry		0.81			6	32	
Chromium	61.9	1.0	mg/kg dry		67.6			9	32	
Cobalt	13.8	0.1	mg/kg dry		14.1			2	26	
Copper	67.8	0.2	mg/kg dry		61.3			10	38	
Lead	14.5	0.2	mg/kg dry		11.8			20	46	
Mercury	0.05	0.04	mg/kg dry		0.05				42	
Molybdenum	5.0	0.1	mg/kg dry		4.5			9	52	
Nickel	50.0	0.4	mg/kg dry		53.5			7	29	
Selenium	2.9	0.5	mg/kg dry		2.9			2	19	
Silver	0.8	0.2	mg/kg dry		0.8				35	
Thallium	0.1	0.1	mg/kg dry		0.1				27	
Tin	0.2	0.2	mg/kg dry		0.2				85	
Uranium	0.58	0.05	mg/kg dry		0.56			3	36	
Vanadium	63.8	0.4	mg/kg dry		65.5			3	23	
Zinc	89	2	mg/kg dry		85			4	30	
Reference (B7A1371-SRM1)				Prepared: 2017-01-27, Analyzed: 2017-01-27						
Antimony	5.9	0.1	mg/kg dry	6.27		94	73-138			
Arsenic	15.1	0.4	mg/kg dry	15.4		98	87-106			
Barium	77	1	mg/kg dry	80.6		95	72-119			
Beryllium	0.5	0.1	mg/kg dry	0.544		90	73-128			
Cadmium	0.22	0.04	mg/kg dry	0.230		94	88-121			
Chromium	27.7	1.0	mg/kg dry	27.2		102	91-113			

Strong Acid Leachable Metals, Batch B7A1371, Continued

Reference (B7A1371-SRM1), Continued — Prepared: 2017-01-27, Analyzed: 2017-01-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Cobalt	12.0	0.1	mg/kg dry	12.5		96	90-109			
Copper	43.6	0.2	mg/kg dry	44.9		97	92-112			
Lead	13.8	0.2	mg/kg dry	14.4		96	89-111			
Mercury	0.11	0.04	mg/kg dry	0.0980		117	74-126			
Molybdenum	0.7	0.1	mg/kg dry	0.738		95	93-120			
Nickel	17.0	0.4	mg/kg dry	17.4		98	93-110			
Tin	1.0	0.2	mg/kg dry	1.10		87	78-120			
Uranium	0.79	0.05	mg/kg dry	0.940		84	80-102			
Vanadium	54.8	0.4	mg/kg dry	54.9		100	87-116			
Zinc	64	2	mg/kg dry	67.5		95	91-113			

Strong Acid Leachable Metals, Batch B7B0261

Blank (B7B0261-BLK1) — Prepared: 2017-02-06, Analyzed: 2017-02-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony	< 0.1	0.1	mg/kg dry							
Arsenic	< 0.4	0.4	mg/kg dry							
Barium	< 1	1	mg/kg dry							
Beryllium	< 0.1	0.1	mg/kg dry							
Cadmium	< 0.04	0.04	mg/kg dry							
Chromium	< 1.0	1.0	mg/kg dry							
Cobalt	< 0.1	0.1	mg/kg dry							
Copper	< 0.2	0.2	mg/kg dry							
Lead	< 0.2	0.2	mg/kg dry							
Mercury	< 0.04	0.04	mg/kg dry							
Molybdenum	< 0.1	0.1	mg/kg dry							
Nickel	< 0.4	0.4	mg/kg dry							
Selenium	< 0.5	0.5	mg/kg dry							
Silver	< 0.2	0.2	mg/kg dry							
Thallium	< 0.1	0.1	mg/kg dry							
Tin	< 0.2	0.2	mg/kg dry							
Uranium	< 0.05	0.05	mg/kg dry							
Vanadium	< 0.4	0.4	mg/kg dry							
Zinc	< 2	2	mg/kg dry							

Blank (B7B0261-BLK2) — Prepared: 2017-02-06, Analyzed: 2017-02-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony	< 0.1	0.1	mg/kg dry							
Arsenic	< 0.4	0.4	mg/kg dry							
Barium	< 1	1	mg/kg dry							
Beryllium	< 0.1	0.1	mg/kg dry							
Cadmium	< 0.04	0.04	mg/kg dry							
Chromium	< 1.0	1.0	mg/kg dry							
Cobalt	< 0.1	0.1	mg/kg dry							
Copper	< 0.2	0.2	mg/kg dry							
Lead	< 0.2	0.2	mg/kg dry							
Mercury	< 0.04	0.04	mg/kg dry							
Molybdenum	< 0.1	0.1	mg/kg dry							
Nickel	< 0.4	0.4	mg/kg dry							
Selenium	< 0.5	0.5	mg/kg dry							
Silver	< 0.2	0.2	mg/kg dry							
Thallium	< 0.1	0.1	mg/kg dry							
Tin	< 0.2	0.2	mg/kg dry							
Uranium	< 0.05	0.05	mg/kg dry							
Vanadium	< 0.4	0.4	mg/kg dry							
Zinc	< 2	2	mg/kg dry							

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Strong Acid Leachable Metals, Batch B7B0261, Continued

Reference (B7B0261-SRM1) Prepared: 2017-02-06, Analyzed: 2017-02-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony	6.2	0.1	mg/kg dry	6.27		100	73-138			
Arsenic	15.5	0.4	mg/kg dry	15.4		101	87-106			
Barium	78	1	mg/kg dry	80.6		97	72-119			
Beryllium	0.5	0.1	mg/kg dry	0.544		86	73-128			
Cadmium	0.24	0.04	mg/kg dry	0.230		104	88-121			
Chromium	26.8	1.0	mg/kg dry	27.2		98	91-113			
Cobalt	12.2	0.1	mg/kg dry	12.5		97	90-109			
Copper	43.9	0.2	mg/kg dry	44.9		98	92-112			
Lead	13.4	0.2	mg/kg dry	14.4		93	89-111			
Mercury	0.09	0.04	mg/kg dry	0.0980		95	74-126			
Molybdenum	0.7	0.1	mg/kg dry	0.738		95	93-120			
Nickel	17.1	0.4	mg/kg dry	17.4		98	93-110			
Tin	1.0	0.2	mg/kg dry	1.10		92	78-120			
Uranium	0.82	0.05	mg/kg dry	0.940		87	80-102			
Vanadium	53.4	0.4	mg/kg dry	54.9		97	87-116			
Zinc	63	2	mg/kg dry	67.5		94	91-113			

Reference (B7B0261-SRM2) Prepared: 2017-02-06, Analyzed: 2017-02-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony	6.1	0.1	mg/kg dry	6.27		98	73-138			
Arsenic	15.4	0.4	mg/kg dry	15.4		100	87-106			
Barium	78	1	mg/kg dry	80.6		97	72-119			
Beryllium	0.5	0.1	mg/kg dry	0.544		92	73-128			
Cadmium	0.22	0.04	mg/kg dry	0.230		96	88-121			
Chromium	26.8	1.0	mg/kg dry	27.2		99	91-113			
Cobalt	12.3	0.1	mg/kg dry	12.5		98	90-109			
Copper	44.4	0.2	mg/kg dry	44.9		99	92-112			
Lead	13.2	0.2	mg/kg dry	14.4		92	89-111			
Mercury	0.10	0.04	mg/kg dry	0.0980		99	74-126			
Molybdenum	0.7	0.1	mg/kg dry	0.738		100	93-120			
Nickel	17.0	0.4	mg/kg dry	17.4		98	93-110			
Tin	0.9	0.2	mg/kg dry	1.10		86	78-120			
Uranium	0.82	0.05	mg/kg dry	0.940		88	80-102			
Vanadium	53.5	0.4	mg/kg dry	54.9		97	87-116			
Zinc	63	2	mg/kg dry	67.5		94	91-113			

QC Qualifiers:

HT1	The sample was prepared and/or analyzed past the recommended holding time.
SRM	Recovery of one or more analytes on Standard Reference Material (SRM) analysis are outside of control limits.

		7011325-01	7011325-02	7011325-03	7011325-04	7011325-05	7011325-06
		Tissue (dry)	**Tissue (dry)**	**Tissue (dry)**	**Tissue (dry)**	**Tissue (dry)**	**Tissue (dry)**
		2016-07-01	**2016-07-08**	**2016-07-22**	**2016-07-10**	**2016-07-09**	**2016-07-04**
		V33 (leaf)	**023 (leaf)**	**V38 (leaf)**	**V36 (leaf)**	**026 (leaf)**	**1 (leaf)**
General Parameters	Moisture (% wet)	63.4	67.9	69.3	70.3	65.9	62.9
Metals in Tissue	Aluminum (mg/kg dry)	149	65.3	11.8	21.1	84.8	75.6
	Antimony (mg/kg dry)	0.080	0.032	0.006	0.012	0.042	0.034
	Arsenic (mg/kg dry)	1.03	0.379	0.060	0.071	0.963	0.364
	Barium (mg/kg dry)	44.1	18.7	72.2	99.3	6.28	16.9
	Beryllium (mg/kg dry)	0.007	0.002	< 0.002	< 0.002	0.003	0.003
	Bismuth (mg/kg dry)	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	Boron (mg/kg dry)	7.0	25.3	38.8	58.3	28.1	22.0
	Cadmium (mg/kg dry)	7.25	3.32	2.90	2.50	0.639	4.25
	Calcium (mg/kg dry)	24300	17100	20000	22300	25600	16700
	Chromium (mg/kg dry)	0.68	0.30	0.17	0.16	0.35	0.39
	Cobalt (mg/kg dry)	1.32	0.373	0.370	0.506	1.26	0.937
	Copper (mg/kg dry)	11.6	8.47	17.8	9.53	2.99	12.9
	Iron (mg/kg dry)	381	205	90	89	247	226
	Lead (mg/kg dry)	0.378	0.149	0.038	0.091	0.193	0.167
	Magnesium (mg/kg dry)	2870	2590	3230	3680	4800	3480
	Manganese (mg/kg dry)	402	70.8	158	230	692	240
	Mercury (mg/kg dry)	0.010	0.013	0.006	0.009	0.010	0.011
	Molybdenum (mg/kg dry)	0.20	0.45	0.45	0.22	0.14	0.42
	Nickel (mg/kg dry)	13.3	5.55	2.58	0.63	0.84	8.29
	Phosphorus (mg/kg dry)	1900	2870	4510	4700	2760	3110
	Potassium (mg/kg dry)	12500	21000	15300	19000	13500	15400
	Selenium (mg/kg dry)	1.35	3.12	0.16	0.09	0.85	0.90
	Silver (mg/kg dry)	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Sodium (mg/kg dry)	39	26	20	18	34	29
	Strontium (mg/kg dry)	101	58.0	67.1	78.5	113	55.9
	Thallium (mg/kg dry)	0.002	< 0.001	< 0.001	0.002	0.001	0.002
	Tin (mg/kg dry)	0.03	0.02	< 0.02	< 0.02	< 0.02	< 0.02
	Titanium (mg/kg dry)	4.64	2.26	0.53	0.94	4.22	2.83
	Uranium (mg/kg dry)	0.004	0.003	< 0.001	< 0.001	0.003	0.003
	Vanadium (mg/kg dry)	0.46	0.20	0.04	0.07	0.27	0.29
	Zinc (mg/kg dry)	355	158	124	143	43.0	212

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		7011325-07	7011325-08	7011325-09	7011325-10	7011325-11	7011325-12
		Tissue (dry)	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
		2016-07-08	**2016-07-04**	**2016-07-08**	**2016-07-09**	**2016-07-10**	**2016-07-06**
		Plot 22 (leaf)	**001 0-15 cm (soil)**	**V24 0-15 (soil)**	**30 0-15 (soil)**	**FS882 Plot 32 0-15 (soil)**	**012 0-15 (soil)**
General Parameters	Calcium Carbonate Equivalence (% dry)		1.5	0.5	2.8	3.0	3.4
	Moisture (% wet)	71.6					
	Carbon, Total Organic (% dry)		7.65	3.22	4.04	1.29	4.35
Salinity Parameters (Sat. Paste Extract)	pH, Saturated Paste (pH units)		5.0	5.0	4.8	5.5	5.2
	Conductivity, Saturated Paste (ds/m)		< 0.10	< 0.10	0.16	0.93	< 0.10
	Sodium Adsorption Ratio (-)		0.6	0.4	1.4	0.2	0.1
	Calcium, Saturated Paste (mg/L)		5.6	8.0	< 4.0	124	< 4.0
	Calcium, Saturated Paste (meq/L)		0.3	0.4	< 0.2	6.2	< 0.2
	Magnesium, Saturated Paste (mg/L)		2.1	1.8	2.0	26.1	0.9
	Magnesium, Saturated Paste (meq/L)		0.2	0.1	0.2	2.1	0.07
	Potassium, Saturated Paste (mg/L)		2.6	2.7	3.0	8.2	< 0.4
	Potassium, Saturated Paste (meq/L)		0.07	0.07	0.08	0.2	< 0.01
	Sodium, Saturated Paste (mg/L)		7.0	4.4	10.8	8.5	1.0
	Sodium, Saturated Paste (meq/L)		0.3	0.2	0.5	0.4	0.05
Particle Size Distribution	> 2.0 mm (%)		41.4	26.2	41.2	5.9	34.2
	Sand (% dry)		40	55	41	69	46
	Silt (% dry)		< 2	4	4	7	3
	Clay (% dry)		17	15	14	19	16
Strong Acid Leachable Metals	Antimony (mg/kg dry)		3.2	7.4	4.2	5.6	1.8
	Arsenic (mg/kg dry)		59.4	36.1	30.0	32.2	22.3
	Barium (mg/kg dry)		91	70	79	181	126
	Beryllium (mg/kg dry)		0.6	0.9	0.4	0.5	0.5
	Cadmium (mg/kg dry)		0.42	0.17	0.16	1.36	1.13
	Chromium (mg/kg dry)		21.6	8.3	22.8	16.8	20.0
	Cobalt (mg/kg dry)		11.2	20.1	23.2	17.3	14.6
	Copper (mg/kg dry)		85.9	90.0	104	86.0	26.2
	Lead (mg/kg dry)		23.0	16.4	34.3	42.7	42.4
	Mercury (mg/kg dry)		0.07	0.05	0.08	0.05	0.08
	Molybdenum (mg/kg dry)		9.6	9.5	12.5	7.0	1.3
	Nickel (mg/kg dry)		18.0	31.8	36.9	43.8	15.0
	Selenium (mg/kg dry)		2.2	1.4	1.8	2.2	< 0.5
	Silver (mg/kg dry)		0.5	< 0.2	0.4	1.0	< 0.2
	Thallium (mg/kg dry)		0.2	0.3	0.4	0.2	0.3
	Tin (mg/kg dry)		0.7	0.2	0.5	< 0.2	0.3
	Uranium (mg/kg dry)		0.74	0.44	0.51	0.53	0.49
	Vanadium (mg/kg dry)		78.9	33.3	81.8	45.1	65.0
	Zinc (mg/kg dry)		120	36	48	132	242
Metals in Tissue	Aluminum (mg/kg dry)	25.3					
	Antimony (mg/kg dry)	0.010					
	Arsenic (mg/kg dry)	0.179					
	Barium (mg/kg dry)	24.0					
	Beryllium (mg/kg dry)	< 0.002					
	Bismuth (mg/kg dry)	< 0.02					
	Boron (mg/kg dry)	50.7					

REPORTED TO	EcoLogic	**WORK ORDER**	7011325
PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

		7011325-07	7011325-08	7011325-09	7011325-10	7011325-11	7011325-12
		Tissue (dry)	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
		2016-07-08	**2016-07-04**	**2016-07-08**	**2016-07-09**	**2016-07-10**	**2016-07-06**
		Plot 22 (leaf)	**001 0-15 cm (soil)**	**V24 0-15 (soil)**	**30 0-15 (soil)**	**FS882 Plot 32 0-15 (soil)**	**012 0-15 (soil)**
Metals in Tissue	Cadmium (mg/kg dry)	6.31					
	Calcium (mg/kg dry)	23000					
	Chromium (mg/kg dry)	0.20					
	Cobalt (mg/kg dry)	0.398					
	Copper (mg/kg dry)	11.6					
	Iron (mg/kg dry)	108					
	Lead (mg/kg dry)	0.067					
	Magnesium (mg/kg dry)	2330					
	Manganese (mg/kg dry)	140					
	Mercury (mg/kg dry)	0.019					
	Molybdenum (mg/kg dry)	0.40					
	Nickel (mg/kg dry)	3.35					
	Phosphorus (mg/kg dry)	3500					
	Potassium (mg/kg dry)	22900					
	Selenium (mg/kg dry)	4.52					
	Silver (mg/kg dry)	< 0.01					
	Sodium (mg/kg dry)	31					
	Strontium (mg/kg dry)	74.8					
	Thallium (mg/kg dry)	0.002					
	Tin (mg/kg dry)	< 0.02					
	Titanium (mg/kg dry)	1.04					
	Uranium (mg/kg dry)	0.005					
	Vanadium (mg/kg dry)	0.08					
	Zinc (mg/kg dry)	163					

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PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

		7011325-13	7011325-14	7011325-15	7011325-16	7011325-17	7011325-18
		Soil	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
		2016-07-06	**2016-07-08**	**2016-07-08**	**2016-07-08**	**2016-07-08**	**2016-07-08**
		011 0-15 (soil)	**V21 0-15 (soil)**	**RW 196 (soil)**	**EL RY 3RW2 (soil)**	**EL RY1 RW2 (soil)**	**OEL Borrow 1 (soil)**
General Parameters	Calcium Carbonate Equivalence (% dry)	2.3	2.9	3.3	4.0	3.5	6.0
	Carbon, Total Organic (% dry)	1.58	3.58	1.97	0.23	0.31	0.74
Salinity Parameters (Sat. Paste Extract)	pH, Saturated Paste (pH units)	5.0	5.0	5.0	5.1	5.6	8.0
	Conductivity, Saturated Paste (ds/m)	< 0.10	0.14	0.41	0.14	< 0.10	0.31
	Sodium Adsorption Ratio (-)	0.4	0.4	0.1	0.1	0.1	< 0.1
	Calcium, Saturated Paste (mg/L)	< 4.0	8.2	40.9	16.9	4.4	71.2
	Calcium, Saturated Paste (meq/L)	< 0.2	0.4	2.0	0.8	0.2	3.6
	Magnesium, Saturated Paste (mg/L)	1.4	4.4	10.7	3.7	1.5	2.8
	Magnesium, Saturated Paste (meq/L)	0.1	0.4	0.9	0.3	0.1	0.2
	Potassium, Saturated Paste (mg/L)	3.3	2.3	8.5	2.8	2.7	4.3
	Potassium, Saturated Paste (meq/L)	0.09	0.06	0.2	0.07	0.07	0.1
	Sodium, Saturated Paste (mg/L)	2.6	5.5	3.3	1.3	1.3	0.7
	Sodium, Saturated Paste (meq/L)	0.1	0.2	0.1	0.06	0.06	0.03
Particle Size Distribution	> 2.0 mm (%)	51.8	42.4	38.0	69.2	80.6	50.7
	Sand (% dry)	44	47	47	30	16	35
	Silt (% dry)	< 2	3	4	< 2	< 2	5
	Clay (% dry)	3	8	11	< 2	3	9
Strong Acid Leachable Metals	Antimony (mg/kg dry)	4.0	3.0	2.1	3.4	1.5	1.9
	Arsenic (mg/kg dry)	73.6	25.0	28.5	42.5	21.5	20.8
	Barium (mg/kg dry)	54	114	107	65	316	157
	Beryllium (mg/kg dry)	0.3	0.5	0.4	0.2	0.2	0.3
	Cadmium (mg/kg dry)	0.45	0.36	0.50	0.45	0.62	0.78
	Chromium (mg/kg dry)	29.0	30.6	25.7	16.8	13.6	79.2
	Cobalt (mg/kg dry)	13.3	17.9	12.5	7.7	10.9	15.4
	Copper (mg/kg dry)	194	85.2	66.1	69.6	107	56.6
	Lead (mg/kg dry)	22.5	11.8	17.0	15.4	9.6	12.8
	Mercury (mg/kg dry)	< 0.04	0.06	0.07	< 0.04	< 0.04	< 0.04
	Molybdenum (mg/kg dry)	32.6	4.7	2.7	12.0	27.2	2.1
	Nickel (mg/kg dry)	30.3	50.4	21.4	17.4	15.3	50.1
	Selenium (mg/kg dry)	3.2	3.0	0.9	3.9	2.7	1.2
	Silver (mg/kg dry)	0.5	< 0.2	0.7	0.6	0.5	0.5
	Thallium (mg/kg dry)	< 0.1	0.1	0.1	< 0.1	< 0.1	< 0.1
	Tin (mg/kg dry)	0.3	0.3	0.2	< 0.2	< 0.2	0.3
	Uranium (mg/kg dry)	1.18	0.32	0.77	1.06	0.60	1.22
	Vanadium (mg/kg dry)	99.3	70.8	67.8	70.0	68.7	74.5
	Zinc (mg/kg dry)	138	93	85	90	102	89

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PROJECT	Red Mountain Baseline	**REPORTED**	2017-02-09

		7011325-19	7011325-20	7011325-21	7011325-22	7011325-23	7011325-24
		Soil	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
		2016-07-08	**2016-07-08**	**2016-07-08**	**2016-07-08**	**2016-07-08**	**2016-07-08**
		534 RW/RW2 (soil)	**Borrow A (soil)**	**RW 38 (soil)**	**KL113 (soil)**	**Radio EL 5 RW2**	**RW 114 (soil)**
General Parameters	Calcium Carbonate Equivalence (% dry)	3.5	3.0	3.5	4.0	1.5	4.0
	Carbon, Total Organic (% dry)	0.41	2.04	0.84	1.58	1.62	0.54
Salinity Parameters (Sat. Paste Extract)	pH, Saturated Paste (pH units)	7.6	5.7	4.9	7.4	5.3	7.8
	Conductivity, Saturated Paste (ds/m)	0.39	0.41	0.12	1.02	< 0.10	0.77
	Sodium Adsorption Ratio (-)	< 0.1	< 0.1	0.2	< 0.1	0.2	< 0.1
	Calcium, Saturated Paste (mg/L)	73.4	54.4	10.3	210	< 4.0	167
	Calcium, Saturated Paste (meq/L)	3.7	2.7	0.5	10.5	< 0.2	8.3
	Magnesium, Saturated Paste (mg/L)	3.5	12.5	5.9	6.0	2.3	8.9
	Magnesium, Saturated Paste (meq/L)	0.3	1.0	0.5	0.5	0.2	0.7
	Potassium, Saturated Paste (mg/L)	10.9	7.4	13.7	5.8	8.0	12.4
	Potassium, Saturated Paste (meq/L)	0.3	0.2	0.4	0.1	0.2	0.3
	Sodium, Saturated Paste (mg/L)	< 0.4	1.1	2.7	0.4	1.5	0.9
	Sodium, Saturated Paste (meq/L)	< 0.02	0.05	0.1	0.02	0.07	0.04
Particle Size Distribution	> 2.0 mm (%)	52.5	92.6	75.3	28.8	69.6	43.2
	Sand (% dry)	46	6	20	50	26	46
	Silt (% dry)	< 2	< 2	4	4	< 2	3
	Clay (% dry)	< 2	< 2	< 2	17	4	8
Strong Acid Leachable Metals	Antimony (mg/kg dry)	2.3	1.8	4.7	2.6	3.8	2.6
	Arsenic (mg/kg dry)	16.3	14.0	60.0	124	23.9	24.0
	Barium (mg/kg dry)	90	247	141	176	87	91
	Beryllium (mg/kg dry)	0.3	0.6	0.2	0.4	0.5	0.3
	Cadmium (mg/kg dry)	0.64	0.38	0.68	0.86	0.43	1.02
	Chromium (mg/kg dry)	67.2	33.3	21.3	22.4	18.0	55.3
	Cobalt (mg/kg dry)	10.7	18.5	9.8	13.5	15.2	12.7
	Copper (mg/kg dry)	59.7	72.0	99.1	69.9	79.3	60.4
	Lead (mg/kg dry)	8.7	16.8	28.5	18.8	26.1	12.5
	Mercury (mg/kg dry)	< 0.04	0.07	0.04	< 0.04	0.06	0.04
	Molybdenum (mg/kg dry)	5.0	1.8	15.4	2.2	3.9	5.4
	Nickel (mg/kg dry)	39.8	18.8	22.2	30.2	39.0	46.0
	Selenium (mg/kg dry)	1.8	< 0.5	4.7	2.4	1.8	3.1
	Silver (mg/kg dry)	0.5	0.4	1.0	0.6	0.6	0.7
	Thallium (mg/kg dry)	< 0.1	0.1	0.1	0.2	0.1	0.1
	Tin (mg/kg dry)	< 0.2	0.3	0.3	0.2	< 0.2	< 0.2
	Uranium (mg/kg dry)	0.46	0.39	1.92	0.50	0.38	0.56
	Vanadium (mg/kg dry)	60.3	95.9	89.2	61.0	46.9	59.9
	Zinc (mg/kg dry)	74	82	114	96	86	98

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		7011325-25	7011325-26	7011325-27	7011325-28
		Soil	**Soil**	**Soil**	**Soil**
		2016-07-08	**2016-07-08**	**2016-07-08**	**2016-07-08**
		RW 78 (soil)	**EL RY2 (soil)**	**RW 92 (soil)**	**Rm 001 0-15 (soil)**
General Parameters	Calcium Carbonate Equivalence (% dry)	2.5	7.5	5.0	1.5
	Carbon, Total Organic (% dry)	0.43	0.93	0.40	4.38
Salinity Parameters (Sat. Paste Extract)	pH, Saturated Paste (pH units)	8.0	7.8	7.3	5.9
	Conductivity, Saturated Paste (ds/m)	0.53	0.39	0.73	< 0.10
	Sodium Adsorption Ratio (-)	< 0.1	< 0.1	< 0.1	0.2
	Calcium, Saturated Paste (mg/L)	113	85.4	156	< 4.0
	Calcium, Saturated Paste (meq/L)	5.6	4.3	7.8	< 0.2
	Magnesium, Saturated Paste (mg/L)	3.0	4.0	10.2	1.0
	Magnesium, Saturated Paste (meq/L)	0.2	0.3	0.8	0.09
	Potassium, Saturated Paste (mg/L)	3.1	2.9	9.5	< 0.4
	Potassium, Saturated Paste (meq/L)	0.08	0.08	0.2	< 0.01
	Sodium, Saturated Paste (mg/L)	1.0	0.8	1.5	1.2
	Sodium, Saturated Paste (meq/L)	0.04	0.04	0.06	0.05
Particle Size Distribution	> 2.0 mm (%)	32.5	37.4	70.1	23.5
	Sand (% dry)	36	57	24	62
	Silt (% dry)	14	< 2	< 2	4
	Clay (% dry)	18	4	4	11
Strong Acid Leachable Metals	Antimony (mg/kg dry)	2.0	2.5	2.4	2.5
	Arsenic (mg/kg dry)	19.8	16.0	19.9	21.3
	Barium (mg/kg dry)	142	300	89	55
	Beryllium (mg/kg dry)	0.4	0.5	0.3	0.3
	Cadmium (mg/kg dry)	0.78	0.56	0.81	0.16
	Chromium (mg/kg dry)	75.9	25.9	67.6	28.3
	Cobalt (mg/kg dry)	15.6	15.6	14.1	7.9
	Copper (mg/kg dry)	68.3	61.9	61.3	51.6
	Lead (mg/kg dry)	10.2	22.0	11.8	12.1
	Mercury (mg/kg dry)	< 0.04	< 0.04	0.05	0.05
	Molybdenum (mg/kg dry)	4.9	1.6	4.5	4.2
	Nickel (mg/kg dry)	55.4	25.8	53.5	26.1
	Selenium (mg/kg dry)	1.7	0.6	2.9	3.0
	Silver (mg/kg dry)	0.5	0.4	0.8	1.1
	Thallium (mg/kg dry)	< 0.1	0.1	0.1	0.1
	Tin (mg/kg dry)	0.3	< 0.2	< 0.2	0.3
	Uranium (mg/kg dry)	0.55	0.36	0.56	0.32
	Vanadium (mg/kg dry)	83.4	79.5	65.5	65.4
	Zinc (mg/kg dry)	83	84	85	55

APPENDIX I. POTENTIAL CDC LISTED PLANTS AND LICHENS IN THE RSA

Appendix I. Potential CDC Listed Plants and Lichens in the RSA

Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	Name Category	BGC	Habitat Subtype
Amblyodon dealbatus		G3G5	S3		Blue	Nonvascular Plant	BWBS;SWB	
Andreaea rupestris var. *papillosa*		G5TNR	S1		Red	Nonvascular Plant	BAFA;CMA;CWH;ESSF;SWB	
Arctanthemum arcticum ssp. *arcticum*	Arctic daisy	G5TNR	SH		Red	Vascular Plant	CWHwm	Marsh;Stream/River;Intertidal Marine;Mudflats - Intertidal
Arctopoa eminens	eminent bluegrass	G5	S1S2		Red	Vascular Plant	CWHvm	Intertidal Marine;Beach
Botrychium ascendens	upswept moonwort	G3	S3		Blue	Vascular Plant	BAFA;CMA;CWHxm;ESSFdk;ESSFmm;IDFdk;IDFxh;IMA	Riparian Forest;Meadow;Conifer Forest - Mesic (average);Alpine/Subalpine Meadow
Botrychium crenulatum	dainty moonwort	G3	S2S3		Blue	Vascular Plant	BWBSmw;ESSFdk;ICHwk	
Botrychium montanum	mountain moonwort	G3	S2?		Red	Vascular Plant	ICHmc;ICHmw;ICHwk	Conifer Forest - Mesic (average)
Bryhnia hultenii		G4	S1		Red	Nonvascular Plant	CWH;MH	
Bryoerythrophyllum ferruginascens		G3G4	S1S2		Red	Nonvascular Plant	BAFA;CMA	
Callitriche heterophylla var. *heterophylla*	two-edged water-starwort	G5T5	S2S3		Blue	Vascular Plant	BAFAunp;CDFmm;CWHvm;CWHwh;CWHxm	Pond/Open Water
Carex adusta	lesser brown sedge	G5	S1S2		Red	Vascular Plant	ICHmc;ICHmw	Conifer Forest - Dry
Carex gmelinii	Gmelin's sedge	G4G5	S2S3		Blue	Vascular Plant	CWHvh;CWHwh;CWHwm	Cliff;Meadow;Sand Dune
Carex krausei	Krause's sedge	G4	S2S3		Blue	Vascular Plant	ESSFwm;ESSFwv	Tundra;Meadow;Grassland;Sagebrush Steppe;Antelope-brush Steppe;Gravel Bar
Cinclidium arcticum		G4G5	S2S3		Blue	Nonvascular Plant	BAFA;SWB	
Cladonia macroceras	bullet-proof pixie	GNR	S2S3		Blue	Fungus	CWHvh;CWHwh;MHmm	
Cladonia macrophylla	fig-leaf pixie	GNR	S2		Red	Fungus	BAFAunp;MHmm	
Collema auriforme	eared tarpaper	GNR	S1		Red	Fungus	CWHvm;ESSFwvp	
Collema bachmanianum	Caesar's tarpaper	GNR	S2		Red	Fungus	CWHvm	
Collema ceraniscum	pincushion tarpaper	GNR	S1		Red	Fungus	CWHvm	
Collema fecundum	seaside tarpaper	GNR	S3		Blue	Fungus	CWHvm;CWHws;ESSFwc;ICHdw;ICHmc;IDFxh	
Collema polycarpon	gilled tarpaper	GNR	S2		Red	Fungus	CMAunp;CWHvh;CWHws;SBSmc	
Cornus suecica	dwarf bog bunchberry	G5	S3		Blue	Vascular Plant	CMA;CWHvh;CWHwm	Bog;Marsh;Tundra;Meadow;Conifer Forest - Mesic (average);Conifer Forest - Moist/wet
Cynodontium schisti		G3G5	S3		Blue	Nonvascular Plant	BAFA;SWB	
Dicranodontium asperulum		G4G5	S3		Blue	Nonvascular Plant	CWH;MH	
Didymodon asperifolius		G3G5	S2		Red	Nonvascular Plant	SWB	
Didymodon johansenii		G5?	S2S3		Blue	Nonvascular Plant	SWB	
Diphyscium foliosum		G5	S2S3		Blue	Nonvascular Plant	CWH	
Draba cinerea	gray-leaved draba	G5	S2S3		Blue	Vascular Plant	BAFA;BWBSdk;CMA;IMA;SBSdh;SWBun	Stream/River;Cliff;Rock/Sparsely Vegetated Rock;Meadow;Beach

Appendix I. Potential CDC Listed Plants and Lichens in the RSA

Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	Name Category	BGC	Habitat Subtype
Draba corymbosa	Baffin Bay draba	G4G5	S3		Blue	Vascular Plant	BAFA;CMA	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Glacier/Icefield;Meadow;Krummholtz;Alpine/Subalpine Meadow;Alpine Grassland;Heath;Fellfield;Nivation;Zoogenic
Draba fladnizensis	Austrian draba	G4	S3		Blue	Vascular Plant	BAFA;CMA;IMA;SBSmk;SWBun	Cliff;Rock/Sparsely Vegetated Rock;Talus;Meadow
Draba lactea	milky draba	G5	S3		Blue	Vascular Plant	BAFA;BWBS;CMA;ESSFmv;ESSFvcp;ESSFwm;ESSFwmp;ESSFwv;ESSFxv;IMAun;SWBmk;SWBun	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow;Alpine/Subalpine Meadow
Draba ruaxes	coast mountain draba	G4	S3		Blue	Vascular Plant	BAFA;CMA;IMA;SBSdk	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Glacier/Icefield;Meadow;Krummholtz;Alpine/Subalpine Meadow;Alpine Grassland;Heath;Fellfield;Nivation;Zoogenic
Draba stenopetala	star-flowered draba	G3G4	S1S2		Red	Vascular Plant	BAFA;CMA	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow
Draba thompsonii	lance-fruited draba	G5T3T4Q	S2S3		Blue	Vascular Plant	BAFA;CMA;IMA	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow
Draba ventosa	Wind River draba	G3	S3		Blue	Vascular Plant	BAFA;CMA;IMA	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra
Dryopteris cristata	crested wood fern	G5	S3		Blue	Vascular Plant	ESSFwc;ICHdw;ICHmc;ICHmw;ICHvk;ICHwk;ICHxw;IDFmw;IDFxh;SBSmk	Swamp;Riparian Shrub;Conifer Forest - Moist/wet
Eleocharis kamtschatica	Kamchatka spike-rush	G4	S3		Blue	Vascular Plant	CWHvh;CWHvm;CWHwh;CWHwm	Bog;Marsh;Meadow;Pond/Open Water
Encalypta brevipes		G3	S3		Blue	Nonvascular Plant	BAFA;SBS	
Epilobium hornemannii ssp. *behringianum*	Hornemann's willowherb	G5T4	S2S3		Blue	Vascular Plant	CWHwh;ICHmm;ICHvc;SWBmk;SWBun	Bog;Fen;Swamp;Marsh;Riparian Shrub;Stream/River;Tundra;Glacier/Icefield;Meadow;Krummholtz;Sand Dune;Riparian Herbaceous;Alpine/Subalpine Meadow;Alpine Grassland;Heath;Fellfield;Nivation;Zoogenic
Erigeron uniflorus var. *eriocephalus*	northern daisy	G5T4	S2S3		Blue	Vascular Plant	BAFA;CMA;SWBun	Rock/Sparsely Vegetated Rock;Tundra;Meadow
Eutrema edwardsii	Edwards wallflower	G4	S3?		Blue	Vascular Plant	BAFA;CMA;SWBmk;SWBun	Talus;Tundra;Riparian Herbaceous
Hygrohypnum alpestre		G3G5	S3		Blue	Nonvascular Plant	BAFA;SWB	
Hygrohypnum alpinum		G4G5	S3		Blue	Nonvascular Plant	BAFA;CWH;ESSF;ICH;IDF;SWB	
Hygrohypnum polare		G4	S2S3		Blue	Nonvascular Plant	BAFA;SBS	

Appendix I. Potential CDC Listed Plants and Lichens in the RSA

Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	Name Category	BGC	Habitat Subtype
Juncus albescens	whitish rush	G5	S3		Blue	Vascular Plant	BAFA;BWBSdk;CMA;ESSFdk;IMA;MSdc;SBPSxc;SWBdk;SWBmk	Fen;Pond/Open Water;Heath
Juncus stygius ssp. *americanus*	bog rush	G5T5	S3		Blue	Vascular Plant		
Lescuraea saxicola		G4G5	S3		Blue	Nonvascular Plant	BAFA;CWH;ESSF;SWB	
Lobaria retigera	smoker's lung	GNR	S3		Blue	Fungus	CWHdm;CWHmm;CWHvh;CWHvm;CWHwh;CWHxm;ESSFmw;ICHmc;IMAunp;MHmm	
Lupinus kuschei	Yukon lupine	G3G4	S2S3		Blue	Vascular Plant	BAFA;BWBSdk;BWBSvk;CMA;SWBmk	Rock/Sparsely Vegetated Rock;Conifer Forest - Dry;Sand Dune
Luzula confusa	northern wood-rush	G5	S2S3		Blue	Vascular Plant	BAFA;BWBSwk;CMA	Rock/Sparsely Vegetated Rock;Tundra
Malaxis brachypoda	white adder's-mouth orchid	G4G5Q	S2S3		Blue	Vascular Plant	BWBSdk;BWBSmw;CDFmm;CWHdm;CWHvm;CWHwh;CWHws;CWHxm;SBSvk	Fen;Riparian Forest;Rock/Sparsely Vegetated Rock;Conifer Forest - Moist/wet;Mudflats - Intertidal
Malaxis paludosa	bog adder's-mouth orchid	G4	S2S3		Blue	Vascular Plant	CWHvh;CWHvm;CWHwh;SBSdw;SBSwk	Bog;Swamp;Conifer Forest - Moist/wet
Micranthes nelsoniana var. *carlottae*	dotted saxifrage	G5T3	S3		Blue	Vascular Plant	BAFA;BWBSdk;CMA;CWHds;CWHvh;CWHwh;IMA;MHwh;SWBdk;SWBmk;SWBun	Stream/River;Cliff;Rock/Sparsely Vegetated Rock;Talus;Meadow;Heath
Myurella sibirica		G5	S2		Red	Nonvascular Plant	CWH;SWB	
Oreas martiana		G5?	S2		Red	Nonvascular Plant	BAFA;ICH	
Orthothecium strictum		G5?	S3		Blue	Nonvascular Plant	BAFA;SWB	
Orthotrichum pallens		G5	S3		Blue	Nonvascular Plant	ESSF;ICH;SWB	
Orthotrichum rivulare		G4	S3		Blue	Nonvascular Plant	CWHds;CWHms;CWHwh;CWHxm;PPxh	
Oxytropis maydelliana	Maydell's locoweed	G5	S2S3		Blue	Vascular Plant	BAFA;BWBSdk;BWBSmw;BWBSvk;CMA;SWBmk	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow
Packera ogotorukensis	Ogotoruk Creek butterweed	G3G5	S1S2		Red	Vascular Plant	BAFA;BWBSvk;CMA	Stream/River;Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Gravel Bar
Parmotrema crinitum	snuff ruffle	G3G5	S3		Blue	Fungus	BWBSdk;BWBSmw;CWHvh;CWHwh	
Pedicularis verticillata	whorled lousewort	G4	S2S3		Blue	Vascular Plant	BAFA;BWBSdk;CMA;CWHvh;CWHwh;MHwh	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow;Heath
Penstemon gormanii	Gorman's penstemon	G4	S2S3		Blue	Vascular Plant	BWBSdk	Riparian Shrub;Cliff;Rock/Sparsely Vegetated Rock;Talus;Sand Dune;Riparian Herbaceous
Pinguicula villosa	hairy butterwort	G4	S2S3		Blue	Vascular Plant	BWBSdk;CWHvh;CWHwh	Bog;Pond/Open Water

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Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	Name Category	BGC	Habitat Subtype
Pinus albicaulis	whitebark pine	G3G4	S2S3	E (Apr 2010)	Blue	Vascular Plant	BAFAun;BAFAunp;CMAunp;CWHdm;CWHds;CWHms;CWHun;CWHvm;CWHws;ESSFdc;ESSFdcp;ESSFdcw;ESSFdk;ESSFdkp;ESSFdku;ESSFdkw;ESSFdm;ESSFdmp;ESSFdmw;ESSFdv;ESSFdvp;ESSFdvw;ESSFmc;ESSFmcp;ESSFmk;ESSFmkp;ESSFmm;ESSFmmp;ESSFmv;ESSFmvp;ESSFmw;ESSFmwp;ESSFmww;ESSFvc;ESSFvcp;ESSFvcw;ESSFwc;ESSFwcp;ESSFwcw;ESSFwk;ESSFwm;ESSFwmp;ESSFwmu;ESSFwmw;ESSFwv;ESSFwvp;ESSFxc;ESSFxcp;ESSFxcw;ESSFxv;ESSFxvp;ESSFxvw;ICHdm;ICHdw;ICHmc;ICHmk;ICHmm;ICHmw;ICHvk;ICHwk;IDFdc;IDFdk;IDFdm;IDFdw;IDFww;IDFxc;IDFxh;IMAun;IMAunp;MHmm;MHmmp;MSdc;MSdk;MSdm;MSdv;MSmw;MSxk;MSxv;SBPSxc;SBSdh;SBSmc;SBSvk;SBSwk	Cliff;Rock/Sparsely Vegetated Rock;Talus;Conifer Forest - Mesic (average);Conifer Forest - Dry
Plantago eriopoda	alkali plantain	G5	S3		Blue	Vascular Plant	BWBSdk;ESSFdk;IDFdm;IDFun;MSdk	Marsh;Alkali Ponds/Salt Flats;Lake;Pond/Open Water
Pohlia elongata		G4G5	S3		Blue	Nonvascular Plant	BAFA;CWH;ESSF;ICH;IMA	
Pohlia tundrae		G2G3	S2		Red	Nonvascular Plant	MH	
Polemonium boreale	northern Jacob's-ladder	G5	S3		Blue	Vascular Plant	BAFA;BWBSdk;BWBSvk;CMA;ESSFmv;IMA	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow;Sand Dune
Polystichum setigerum	Alaska holly fern	G3	S2S3		Blue	Vascular Plant	CMA;CWHvm;CWHwh;CWHws	Riparian Forest;Riparian Shrub;Stream/River;Rock/Sparsely Vegetated Rock;Conifer Forest - Moist/wet
Pseudobryum cinclidioides		G5	S2		Red	Nonvascular Plant	BAFA	
Psilopilum cavifolium		G4G5	S1S2		Red	Nonvascular Plant	BAFA	
Ranunculus pedatifidus ssp. *affinis*	birdfoot buttercup	G5T5	S3		Blue	Vascular Plant	BAFA;BWBSdk;BWBSmw;CMA;ESSFxv;ICHwk;IDFdk;IMA;SBPSxc	Rock/Sparsely Vegetated Rock;Tundra;Meadow;Deciduous/Broadleaf Forest
Ranunculus sulphureus	sulphur buttercup	G5	S3		Blue	Vascular Plant	BAFA;CMA	Bog;Stream/River;Rock/Sparsely Vegetated Rock;Tundra;Meadow;Riparian Herbaceous
Rumex arcticus	Arctic dock	G5	S3		Blue	Vascular Plant	BAFA;BWBSdk;CMA;ESSFmv;SBSmk;SWBun	Marsh;Stream/River;Tundra;Meadow
Sagina nivalis	snow pearlwort	G5	S3		Blue	Vascular Plant	BAFA;CMA;SBSmc	Rock/Sparsely Vegetated Rock;Tundra;Beach
Salix petiolaris	meadow willow	G5	S3		Blue	Vascular Plant	BWBSdk;BWBSmw;SBSdh	Bog;Meadow;Deciduous/Broadleaf Forest;Beach;Riparian Herbaceous
Saussurea angustifolia var. *angustifolia*	northern sawwort	G5T5	SH		Red	Vascular Plant	BWBSdk	Bog;Tundra;Meadow

Appendix I. Potential CDC Listed Plants and Lichens in the RSA

Scientific Name	English Name	Global Status	Prov Status	COSEWIC	BC List	Name Category	BGC	Habitat Subtype
Saxifraga serpyllifolia	thyme-leaved saxifrage	G5	S2S3		Blue	Vascular Plant	BAFA;CMA	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Glacier/Icefield;Meadow;Krummholtz;Alpine/Subalpine Meadow;Alpine Grassland;Heath;Fellfield;Nivation;Zoogenic
Schistidium boreale		G4	S2S3		Blue	Nonvascular Plant	BAFA;SWB	
Schistidium pulchrum		GU	S3		Blue	Nonvascular Plant	BWBSdk;BWBSmw;SWBmk	
Sclerophora peronella	frosted glass-whiskers	G3G4	S1	DD (Nov 2014)	Red	Fungus	CWHws	
Senecio sheldonensis	Mount Sheldon butterweed	G3	S3		Blue	Vascular Plant	BAFA;BWBSdk;CMA;IMA;SBSun;SWBdk;SWBmk;SWBun	Meadow;Conifer Forest - Moist/wet
Silene drummondii var. *drummondii*	Drummond's campion	G5T5	S3?		Blue	Vascular Plant	BGxh;BGxw;BWBSmw;ICHmc;IDFdk;IDFxm;MSdk;MSxv;SBPSmk;SBSdk	Meadow;Shrub - Natural;Sagebrush Steppe;Conifer Forest - Dry
Silene involucrata ssp. *involucrata*	arctic campion	G5T5	S3?		Blue	Vascular Plant	BAFA;CMA	Cliff;Rock/Sparsely Vegetated Rock;Tundra;Meadow
Solorina spongiosa	blinking owl	G4G5	S2		Red	Fungus	CWHds;CWHvh;CWHvm;CWHws	
Sphagnum contortum		G5	S3		Blue	Nonvascular Plant	CWH;SBS	
Stereocaulon pileatum	pixie foam	G2G4	S1		Red	Fungus	ICHmc	
Tayloria froelichiana		G3G5	S2S3		Blue	Nonvascular Plant	BAFA;SWB	
Tetraplodon pallidus		G5	S1S2		Red	Nonvascular Plant	BAFA	
Tetrodontium brownianum		G3G4	S3		Blue	Nonvascular Plant	CWH	
Tortula obtusifolia		G5	S3		Blue	Nonvascular Plant	BG;CDF;ICH;IDF	
Ulota curvifolia		G3G5	S3		Blue	Nonvascular Plant	BAFA;ICH;IDF	
Umbilicaria cinereorufescens	questionable rocktripe	GNR	S1?		Red	Fungus	ICHmc;SWBmk	
Umbilicaria lambii	windward rocktripe	G2G4	S3		Blue	Fungus	BWBSdk;CMAunp;ESSFxc;ICHmc	
Usnea cavernosa	pitted beard	G5	S2S3		Blue	Fungus	CWHwh;ESSFwc;ICHmw;MHmm;SWBmk	
Usnea glabrata	lustrous beard	G5	S3		Blue	Fungus	CWHds;CWHvh;CWHwh;ESSFwc;ICHmc;ICHmw;MSdk	
Usnea glabrescens	spotted beard	G5	S3		Blue	Fungus	CWHms;CWHwh;ICHmc;ICHmk;IDFdk;SBSdw;SBSwk;SWBmk	
Warnstorfia tundrae		G5	S2		Red	Nonvascular Plant	BAFA;BWBS;ICH;SWB	
Woodsia alpina	alpine cliff fern	G4G5	S3		Blue	Vascular Plant	SBSdw;SWBmk	Cliff;Rock/Sparsely Vegetated Rock

Search Criteria

Search Type: Plant
AND Species Groups: Plants
AND Regional Districts: Kitimat-Stikine (KSRD) (Restricted to Red, Blue, and Legally designated species)
Sort Order:Scientific Name Ascending

APPENDIX J. PLANTS AND LICHENS IDENTIFIED IN THE PROJECT

Native	Lichen	*Acarospora sinopica* (Wahlenb.) Körber
Native	Lichen	*Agonimia tristicula* (Nyl.) Zahlbr.
Native	Lichen	*Alectoria ochroleuca* (Hoffm.) A. Massal.
Native	Lichen	*Alectoria sarmentosa* (Ach.) Ach. ssp. *sarmentosa*
Native	Lichen	*Amygdalaria panaeola* (Ach.) Hertel & Brodo
Native	Lichen	*Amygdalaria subdissentiens* (Nyl.) Inoue & Brodo
Native	Lichen	*Arthrorhaphis alpina* (Schaerer) R. Sant.
Native	Lichen	*Arthrorhaphis citrinella* (Ach.) Poelt
Native	Lichen	*Aspicilia rosulata* Körb.
Native	Lichen	*Baeomyces carneus* Flörke
Native	Lichen	*Baeomyces rufus* (Hudson) Rebent.
Native	Lichen	*Bellemerea alpina* (Sommerf.) Clauzade & Cl. Roux
Native	Lichen	*Bellemerea cinereorufescens* (Ach.) Clauzade & Cl. Roux
Native	Lichen	*Bellemerea subsorediza* (Lynge) R. Sant.
Native	Lichen	*Biatora cuprea* (Sommerf.) Fr.
Native	Lichen	*Biatora efflorescens* (Hedl.) Räsänen
Native	Lichen	*Biatora flavopunctata* (Tønsberg) Hinteregger & Printzen
Native	Lichen	*Biatora toensbergii* Holien & Printzen
Native	Lichen	*Bilimbia sabuletorum* (Schreb.) Arnold
Native	Lichen	*Bryocaulon divergens* (Ach.) Kärnefelt
Native	Lichen	*Bryoria americana* (Motyka) Holien
Native	Lichen	*Bryoria fuscescens* (Gyelnik) Brodo & D. Hawksw.
Native	Lichen	*Bryoria lanestris* (Ach.) Brodo & D.Hawksw.
Native	Lichen	*Bryoria nitidula* (Th. Fr.) Brodo & D. Hawksw.
Native	Lichen	*Bryoria pseudofuscescens* (Gyeln.) Brodo & D.Hawksw.
Native	Lichen	*Bryoria sp. nov.*
Native	Lichen	*Buellia erubescens* Arnold
Native	Lichen	*Buellia muriformis* A.Nordin & Tønsberg
Native	Lichen	*Caloplaca atrosanguinea* (G.Merr.) I.M.Lamb
Native	Lichen	*Caloplaca cerina* (Hedw.) Th.Fr. aggr.
Native	Lichen	*Candelariella rosulans* (Müll. Arg.) Zahlbr.
Native	Lichen	*Candelariella vitellina* (Hoffm.) Müll. Arg.
Native	Lichen	*Catapyrenium cinereum* (Pers.) Körber
Native	Lichen	*Catapyrenium daedaleum* (Kremp.) Stein
Native	Lichen	*Cavernularia hultenii* Degel.
Native	Lichen	*Cetraria ericetorum ssp. reticulatum* (Räsänen) Kärnefelt
Native	Lichen	*Cetraria islandica* (L.) Ach. ssp. *islandica*
Native	Lichen	*Cetraria islandica* ssp. *crispiformis* (Räsänen) Kärnefelt
Native	Lichen	*Cetraria nigricans* Nyl.
Native	Lichen	*Cetraria subalpina* Imshaug
Native	Lichen	*Cetrelia cetrarioides* (Delise ex Duby) W.L.Culb. & C.F.Culb.
Native	Lichen	*Chaenotheca brunneola* (Ach.) Müll. Arg.
Native	Lichen	*Chrysothrix chlorina* (Ach.) J.R.Laundon *sensu lato*

Native	Lichen	*Cladina arbuscula* (Wallr.) Hale & W. L. Culb.
Native	Lichen	*Cladina ciliata* (Stirton) Trass
Native	Lichen	*Cladina mitis* (Sandst.) Mong.
Native	Lichen	*Cladina rangiferina* (L.) Nyl.
Native	Lichen	*Cladina stellaris* (Opiz) Brodo
Native	Lichen	*Cladina stygia* (Fr.) Ahti
Native	Lichen	*Cladonia albonigra* Brodo & Ahti
Native	Lichen	*Cladonia amaurocraea* (Flörke) Schaerer
Native	Lichen	*Cladonia bellidiflora* (Ach.) Schaerer
Native	Lichen	*Cladonia borealis* S. Stenroos
Native	Lichen	*Cladonia cariosa* (Ach.) Sprengel
Native	Lichen	*Cladonia carneola* (Fr.) Fr.
Native	Lichen	*Cladonia cenotea* (Ach.) Schaerer
Native	Lichen	*Cladonia cervicornis* (Ach.) Flotow ssp. *cervicornis*
Native	Lichen	*Cladonia chlorophaea* (Flörke ex Sommerf.) Sprengel
Native	Lichen	*Cladonia coccifera* (L.) Willd.
Native	Lichen	*Cladonia cornuta* (L.) Hoffm. *ssp. cornuta*
Native	Lichen	*Cladonia crispata* var. *cetrariiformis* (Delise) Vainio
Native	Lichen	*Cladonia ecmocyna* ssp. *intermedia* (Robbins) Ahti
Native	Lichen	*Cladonia ecmocyna* ssp. *occidentalis* Ahti
Native	Lichen	*Cladonia fimbriata* (L.) Fr.
Native	Lichen	*Cladonia gracilis* ssp. *elongata* (Jacq.) Vainio
Native	Lichen	*Cladonia macilenta* Hoffm.
Native	Lichen	*Cladonia macrophylla* (Schaer.) Stenh.
Native	Lichen	*Cladonia macrophyllodes* Nyl.
Native	Lichen	*Cladonia metacorallifera* Asahina
Native	Lichen	*Cladonia ochrochlora* Flörke
Native	Lichen	*Cladonia phyllophora* Ehrh. ex Hoffm.
Native	Lichen	*Cladonia pleurota* (Flörke) Schaer.
Native	Lichen	*Cladonia pocillum* (Ach.) Grognot
Native	Lichen	*Cladonia pseudalcicornis* Asahina
Native	Lichen	*Cladonia pyxidata* (L.) Hoffm.
Native	Lichen	*Cladonia rei* Schaer.
Native	Lichen	*Cladonia singularis* S. Hammer
Native	Lichen	*Cladonia squamosa* Hoffm.
Native	Lichen	*Cladonia stricta* (Nyl.) Nyl.
Native	Lichen	*Cladonia sulphurina* (Michaux) Fr.
Native	Lichen	*Cladonia symphycarpia* (Flörke) Fr.
Native	Lichen	*Cladonia uncialis* (L.) F. H. Wigg. ssp. *uncialis*
Native	Lichen	*Cladonia uncialis ssp. biuncialis* (Hoffm.) M.Choisy
Native	Lichen	*Cladonia wainioi* Savicz
Native	Lichen	*Coelocaulon aculeatum* (Schreber) Link
Native	Lichen	*Collema ceraniscum* Nyl.

Native	Lichen	*Collema crispum* (Hudson) F. H. Wigg. cfr.
Native	Lichen	*Collema fuscovirens* (With.) J. R. Laundon
Native	Lichen	*Collema tenax* (Swartz) Ach. var. *tenax*
Native	Lichen	*Dendriscocaulon* sp.
Native	Lichen	*Dermatocarpon rivulorum* (Arnold) Dalla Torre & Sarnth.
Native	Lichen	*Diploschistes scruposus* (Schreb.) Norman
Native	Lichen	*Euopsis granatina* (Sommerf.) Nyl.
Native	Lichen	*Euopsis pulvinata* (Schaerer) Nyl.
Native	Lichen	*Flavocetraria cucullata* (Bellardi) Kärnefelt & Thell
Native	Lichen	*Flavocetraria nivalis* (L.) Kärnefelt & Thell
Native	Lichen	*Frutidella caesioatra* (Schaerer) Kalb
Native	Lichen	*Fuscopannaria* ? *cheiroloba* (Müll. Arg.) P. M. Jørg.
Native	Lichen	*Fuscopannaria ahlneri* (P.M.Jørg.) P.M.Jørg.
Native	Lichen	*Fuscopannaria alaskana* P.M.Jørg. & Tønsberg cfr.
Native	Lichen	*Fuscopannaria praetermissa* (Nyl.) P. M. Jørg.
Native	Lichen	*Gowardia nigricans* (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen
Native	Lichen	*Heterodermia* unknown sp.
Native	Lichen	*Hypogymnia apinnata* Goward & McCune
Native	Lichen	*Hypogymnia enteromorpha* (Ach.) Nyl.
Native	Lichen	*Hypogymnia occidentalis* L.H.Pike
Native	Lichen	*Hypogymnia rugosa* (G. Merr.) L. Pike
Native	Lichen	*Hypogymnia vittata* (Ach.) Parrique
Native	Lichen	*Hypotrachyna sinuosa* (Sm.) Hale
Native	Lichen	*Icmadophila ericetorum* (L.) Zahlbr.
Native	Lichen	*Ionaspis lacustris* (With.) Lutzoni
Native	Lichen	*Ionaspis odora* (Ach.) Th. Fr. ex Stein
Native	Lichen	*Koerberiella wimmeriana* (Körber) Stein
Native	Lichen	*Lecanora bicincta* Ramond
Native	Lichen	*Lecanora cadubriae* (A.Massal.) Hedl.
Native	Lichen	*Lecanora chlarotera* Nyl.
Native	Lichen	*Lecanora hybocarpa* (Tuck.) Brodo
Native	Lichen	*Lecanora polytropa* (Hoffm.) Rabenh.
Native	Lichen	*Lecanora stenotropa* Nyl.
Native	Lichen	*Lecanora symmicta* (Ach.) Ach.
Native	Lichen	*Lecidea atrobrunnea* (Ramond ex Lam. & DC.) Schaer. group
Native	Lichen	*Lecidea erythrophaea* Flörke ex Sommerf.
Native	Lichen	*Lecidea lapicida* (Ach.) Ach.
Native	Lichen	*Lecidea pullata* (Norman) Th.Fr.
Native	Lichen	*Lecidoma demissum* (Rutstr.) Gotth. Schneider & Hertel
Native	Lichen	*Lepraria alpina* (B. de Lesd.) Tretiach & Baruffo
Native	Lichen	*Leptogidium contortum* (Henssen) T.Sprib. & Muggia
Native	Lichen	*Leptogidium dendriscum* (Nyl.) Nyl.

Native	Lichen	*Leptogium burnetiae* C.W.Dodge
Native	Lichen	*Leptogium lichenoides* (L.) Zahlbr.
Native	Lichen	*Leptogium saturninum* (Dickson) Nyl.
Native	Lichen	*Leptogium tenuissimum* (Dicks.) Körb.
Native	Lichen	*Lichenomphalia umbellifera* (L.:Fr.) Redhead, Lutzoni, Moncalvo & Vilgalys
Native	Lichen	*Lobaria hallii* (Tuck.) Zahlbr.
Native	Lichen	*Lobaria linita* (Ach.) Rabenh.
Native	Lichen	*Lobaria linita var. tenuior* (Hue) Asah.
Native	Lichen	*Lobaria oregana* (Tuck.) Müll.Arg.
Native	Lichen	*Lobaria pulmonaria* (L.) Hoffm.
Native	Lichen	*Lobaria retigera* (Bory) Trevis.
Native	Lichen	*Lobaria scrobiculata* (Scop.) DC.
Native	Lichen	*Lopadium pezizoideum* (Ach.) Körber
Native	Lichen	*Massalongia carnosa* (Dickson) Körber
Native	Lichen	*Melanelia hepatizon* (Ach.) Thell
Native	Lichen	*Melanelia stygia* (L.) Essl.
Native	Lichen	*Melanelixia subaurifera* (Nyl.) O.Blanco et al.
Native	Lichen	*Micarea melaena* (Nyl.) Hedl.
Native	Lichen	*Micarea peliocarpa* (Anzi) Coppins & R.Sant.
Native	Lichen	*Micarea prasina* Fr. group
Native	Lichen	*Mycobilimbia epixanthoides* (Nyl.) Vitik. et al.
Native	Lichen	*Mycoblastus affinis* (Schaer.) T.Schaeuer
Native	Lichen	*Mycoblastus caesius* (Coppins & P.James) Tønsberg
Native	Lichen	*Mycocalicium subtile* (Pers.) Szatala
Native	Lichen	*Myochroidea rufofusca* (Anzi) Printzen, T. Sprib. & Tønsberg
Native	Lichen	*Nephroma arcticum* (L.) Torss.
Native	Lichen	*Nephroma bellum* (Sprengel) Tuck.
Native	Lichen	*Nephroma expallidum* (Nyl.) Nyl.
Native	Lichen	*Nephroma helveticum* ssp. *sipeanum* (Gyelnik) Goward & Ahti
Native	Lichen	*Nephroma isidiosum* (Nyl.) Gyeln.
Native	Lichen	*Nephroma parile* (Ach.) Ach.
Native	Lichen	*Nephroma resupinatum* (L.) Ach.
Native	Lichen	*Nodobryoria oregana* (Tuck. ex Nyl.) Common & Brodo
Native	Lichen	*Ochrolechia androgyna* (Hoffm.) Arnold
Native	Lichen	*Ochrolechia bryophaga* (Erichsen) K. Schmitz & Lumbsch
Native	Lichen	*Ochrolechia grimmiae* Lynge
Native	Lichen	*Ochrolechia laevigata* (Räsänen) Verseghy ex Kukwa
Native	Lichen	*Ochrolechia oregonensis* H.Magn.
Native	Lichen	*Ophioparma lapponicum* (Räsänen) Hafellner & R.W.Rogers
Native	Lichen	*Ophioparma ventosa* (L.) Norman
Native	Lichen	*Orphniospora moriopsis* (A. Massal.) D. Hawksw.
Native	Lichen	*Parmelia hygrophila* Goward & Ahti

Native	Lichen	*Parmelia omphalodes* (L.) Ach.
Native	Lichen	*Parmelia saxatilis* (L.) Ach.
Native	Lichen	*Parmelia sulcata* Taylor
Native	Lichen	*Parmeliella parvula* P.M.Jørg.
Native	Lichen	*Parmeliella triptophylla* (Ach.) Müll. Arg.
Native	Lichen	*Parmeliopsis ambigua* (Wulfen) Nyl.
Native	Lichen	*Parmeliopsis hyperopta* (Ach.) Arnold
Native	Lichen	*Pellia sp.*
Native	Lichen	*Peltigera chionophila* Goward & Goffinet
Native	Lichen	*Peltigera collina* (Ach.) Schrader
Native	Lichen	*Peltigera conspersa* Goward ined.
Native	Lichen	*Peltigera degenii* Gyelnik sensu lato
Native	Lichen	*Peltigera didactyla* (With.) Laundon
Native	Lichen	*Peltigera extenuata* (Nyl.) Vain.
Native	Lichen	*Peltigera kristinssonii* Vitik.
Native	Lichen	*Peltigera lepidophora* (Nyl. ex Vainio) Bitter
Native	Lichen	*Peltigera leucophlebia* (Nyl.) Gyelnik
Native	Lichen	*Peltigera malacea* (Ach.) Funck
Native	Lichen	*Peltigera membranacea* (Ach.) Nyl.
Native	Lichen	*Peltigera neopolydactyla* (Gyelnik) Gyelnik
Native	Lichen	*Peltigera neorufescens* Goward ined.
Native	Lichen	*Peltigera occidentalis* (E. Dahl) Kristinsson
Native	Lichen	*Peltigera polydactylon* (Necker) Hoffm.
Native	Lichen	*Peltigera ponojensis* Gyelnik
Native	Lichen	*Peltigera rufescens* (Weiss) Humb.
Native	Lichen	*Peltigera scabrosa* Th. Fr.
Native	Lichen	*Peltigera venosa* (L.) Hoffm.
Native	Lichen	*Pertusaria dactylina* (Ach.) Nyl.
Native	Lichen	*Pertusaria geminipara* (Th. Fr.) C. Knight ex Brodo
Native	Lichen	*Pertusaria glaucomela* (Tuck.) Nyl.
Native	Lichen	*Pertusaria oculata* (Dickson) Th. Fr.
Native	Lichen	*Pertusaria sommerfeltii* (Sommerfl.) Fr.
Native	Lichen	*Pertusaria suboculata* Brodo & Dibben
Native	Lichen	*Pertusaria trochiscea* Norman
Native	Lichen	*Phlyctis speirea* G.Merr.
Native	Lichen	*Physcia alnophila* (Vain.) Loht., Moberg, Myllys & Tehler
Native	Lichen	*Physcia caesia* (Hoffm.) Fürnr.
Native	Lichen	*Physcia dubia* (Hoffm.) Lettau
Native	Lichen	*Physcia phaea* (Tuck.) J. W. Thomson
Native	Lichen	*Physconia americana* Essl.
Native	Lichen	*Pilophorus dovrensis* (Nyl.) Timdal, Hertel & Rambold
Native	Lichen	*Placopsis cf. lambii* Hertel & V.Wirth
Native	Lichen	*Placopsis cribellans* (Nyl.) Räsänen

Native	Lichen	*Placynthium asperellum* (Ach.) Trevisan
Native	Lichen	*Placynthium nigrum* (Hudson) A. Gray
Native	Lichen	*Polychidium muscicola* (Sw.) A. Gray
Native	Lichen	*Potamogeton epihydrus* Raf.
Native	Lichen	*Protopannaria pezizoides* (Weber) P. M. Jørg. & S. Ekman
Native	Lichen	*Protoparmelia badia* (Hoffm.) Hafellner
Native	Lichen	*Pseudephebe minuscula* (Nyl. ex Arnold) Brodo & D. Hawksw.
Native	Lichen	*Pseudephebe pubescens* (L.) M. Choisy
Native	Lichen	*Psora decipiens* (Hedwig) Hoffm.
Native	Lichen	*Psoroma hypnorum* (Vahl) A. Gray
Native	Lichen	*Psoroma tenue* var. *boreale* Henssen
Native	Lichen	*Psorotichia schaereri* (A.Massal.) Arnold
Native	Lichen	*Pycnora sorophora* (Vain.) Hafellner
Native	Lichen	*Pyrenopsis furfuracea* (Nyl.) Leighton
Native	Lichen	*Ramboldia cinnabarina* (Sommerf.) Kalb, Lumbsch & Elix
Native	Lichen	*Rhaphidicyrtis* sp. unknown
Native	Lichen	*Rhizocarpon bolanderi* (Tuck.) Herre
Native	Lichen	*Rhizocarpon effiguratum* (Anzi) Th.Fr.
Native	Lichen	*Rhizocarpon geographicum* (L.) DC.
Native	Lichen	*Rhizocarpon inarense* (Vain.) Vain.
Native	Lichen	*Rhizocarpon intermediellum* Räsänen
Native	Lichen	*Rhizocarpon macrosporum* Räsänen
Native	Lichen	*Rhizocarpon viridiatrum* (Wulfen) Körb.
Native	Lichen	*Santessoniella arctophila* (Th.Fr.) Henssen
Native	Lichen	*Santessoniella saximontana* T.Sprib., P.M.Jørg. & M.Schultz
Native	Lichen	*Sareopsis resinae* Björk ined.
Native	Lichen	*Schaereria corticola* Muhr & Tønsberg
Native	Lichen	*Solorina bispora* Nyl.
Native	Lichen	*Solorina crocea* (L.) Ach.
Native	Lichen	*Sphaerophorus fragilis* (L.) Pers.
Native	Lichen	*Sphaerophorus globosus* (Hudson) Vainio
Native	Lichen	*Sphaerophorus tuckermanii* Räsänen
Native	Lichen	*Sphaerophorus venerabilis* Wedin, Högnabba & Goward
Native	Lichen	*Sporastatia testudinea* (Ach.) A.Massal.
Native	Lichen	*Stereocaulon alpinum* Laurer ex Funck
Native	Lichen	*Stereocaulon botryosum* Ach.
Native	Lichen	*Stereocaulon depressum* (Frey) I. M. Lamb
Native	Lichen	*Stereocaulon glareosum* (Savicz) H. Magn.
Native	Lichen	*Stereocaulon grande* (H.Magn.) H.Magn.
Native	Lichen	*Stereocaulon nivale* (Follmann) Fryday
Native	Lichen	*Stereocaulon paschale* (L.) Hoffm.
Native	Lichen	*Stereocaulon rivulorum* H. Magn.
Native	Lichen	*Stereocaulon symphycheilum* I. M. Lamb

Native	Lichen	*Stereocaulon tomentosum* Fr.
Native	Lichen	*Stereocaulon vesuvianum* Pers.
Native	Lichen	*Sticta fuliginosa* (Dicks.) Ach.
Native	Lichen	*Thamnolia vermicularis* (Sw.) Ach. ex Schaerer
Native	Lichen	*Thelotrema lepadinum* (Ach.) Ach.
Native	Lichen	*Thrombium epigaeum* (Pers.) Wallr.
Native	Lichen	*Toensbergia leucococca* (R.Santesson) Bendiksby & Timdal
Native	Lichen	*Trapeliopsis granulosa* (Hoffm.) Lumbsch
Native	Lichen	*Tremolecia atrata* (Ach.) Hertel
Native	Lichen	*Tuckermannopsis chlorophylla* (Willd.) Hale
Native	Lichen	*Umbilicaria angulata* Tuck.
Native	Lichen	*Umbilicaria cylindrica* (L.) Delise ex Duby
Native	Lichen	*Umbilicaria deusta* (L.) Baumg.
Native	Lichen	*Umbilicaria havaasii* Llano
Native	Lichen	*Umbilicaria hyperborea* (Ach.) Hoffm.
Native	Lichen	*Umbilicaria lambii* Imshaug
Native	Lichen	*Umbilicaria proboscidea* (L.) Schrader
Native	Lichen	*Umbilicaria torrefacta* (Lightf.) Schrader
Native	Lichen	*Usnea longissima* Ach.
Native	Lichen	*Usnea scabrata* Nyl.
Native	Lichen	*Vestergrenopsis elaeina* (Wahlenb.) Gyelnik
Native	Lichen	*Vestergrenopsis isidiata* (Degel.) E. Dahl
Native	Lichen	*Xanthoria elegans* (Link) Th. Fr.
Native	Lichen	*Xanthoria sorediata* (Vainio) Poelt
Native	Lichen	*Xylographa vitiligo* (Ach.) J.R.Laundon
Native	Liverwort	*Anastrophyllum michauxii* (F.Weber) H.Buch ex A.Evans
Native	Liverwort	*Anastrophyllum minutum* (Schreb.) R.M.Schust. var. *minutum*
Native	Liverwort	*Anastrophyllum sphenoloboides* R.M.Schust.
Native	Liverwort	*Anthelia juratzkana* (Limpr.) Trev.
Native	Liverwort	*Asterella lindbergeriana* (Corda) Lindb.
Native	Liverwort	*Barbilophozia barbata* (Schreb.) Loeske
Native	Liverwort	*Barbilophozia hatcheri* (A. Evans) Loeske
Native	Liverwort	*Barbilophozia kunzeana* (Huebener) K.Müller
Native	Liverwort	*Barbilophozia lycopodioides* (Wallr.) Loeske
Native	Liverwort	*Blasia pusilla* L.
Native	Liverwort	*Blepharostoma trichophyllum* (L.) Dumort.
Native	Liverwort	*Cephalozia bicuspidata* (L.) Dumort.
Native	Liverwort	*Cephalozia connivens* (Dicks.) Lindb.
Native	Liverwort	*Chiloscyphus pallescens* (Ehrh.) ex Hoffm.) Dumort.
Native	Liverwort	*Conocephalum conicum* (L.) Underw.
Native	Liverwort	*Diplophyllum albicans* (L.) Dumort.
Native	Liverwort	*Diplophyllum apiculatum* (A.Evans) Stephani
Native	Liverwort	*Gymnocolea inflata* (Huds.) Dumort.

Native	Liverwort	*Gymnomitrion apiculatum* (Schiffn.) K.Müller
Native	Liverwort	*Gymnomitrion concinnatum* (Lightf.) Corda
Native	Liverwort	*Gymnomitrion corallioides* Nees
Native	Liverwort	*Lophocolea heterophylla* (Schrad.) Dumort.
Native	Liverwort	*Lophozia collaris* (Mart.) Dumort.
Native	Liverwort	*Lophozia gillmanii* (Austin) R.M.Schust.
Native	Liverwort	*Lophozia quadriloba* (Lindb.) A.Evans
Native	Liverwort	*Lophozia wenzelii* (Nees) Stephani
Native	Liverwort	*Marchantia polymorpha* L.
Native	Liverwort	*Marsupella brevissima* (Dumort.) Grolle
Native	Liverwort	*Marsupella ustulata* (Huebener) Spruce ex Pearson
Native	Liverwort	*Nardia compressa* (Hook.) Gray
Native	Liverwort	*Odontoschisma denudatum* (Nees) Dumort.
Native	Liverwort	*Odontoschisma elongatum* (Lindb.) A.Evans
Native	Liverwort	*Odontoschisma macounii* (Austin) Underw.
Native	Liverwort	*Peltolepis quadrata* (Saut.) K.Müller
Native	Liverwort	*Plagiochila porelloides* (Torr. ex Nees) Lindenb.
Native	Liverwort	*Plagiochila satoi* S.Hatt.
Native	Liverwort	*Pleurocladula albescens* (Hook.) Grolle
Native	Liverwort	*Porella cordeana* (Hüb.) Moore
Native	Liverwort	*Porella navicularis* (Lehm. & Lindenb.) Pfeiff.
Native	Liverwort	*Preissia quadrata* (Scop.) Nees
Native	Liverwort	*Ptilidium californicum* (Austin) Underw.
Native	Liverwort	*Ptilidium ciliare* (L.) Hampe
Native	Liverwort	*Ptilium crista-castrensis* (Hedw.) De Not.
Native	Liverwort	*Radula complanata* (L.) Dumort.
Native	Liverwort	*Sauteria alpina* (Nees) Nees
Native	Liverwort	*Scapania bolanderi* Austin
Native	Liverwort	*Scapania degenii* Schiffn. ex K.Müller
Native	Liverwort	*Scapania irrigua* (Nees) Nees
Native	Liverwort	*Scapania obcordata* (Berggr.) S.W. Arnell
Native	Liverwort	*Scapania subalpina* (Nees ex Lindenb.) Dumort.
Native	Liverwort	*Scapania uliginosa* (Lindenb.) Dumort.
Native	Liverwort	*Schistochilopsis* ? *hyperarctica* (R.M.Schust.) Konstantinova
Native	Liverwort	*Schistochilopsis opacifolia* (Culm.) Konstantinova
Native	Liverwort	*Schofieldia monticola* J.D. Godfrey
Native	Liverwort	*Tetralophozia setiformis* (Ehrh.) Schljakov
Native	Liverwort	*Tritomaria exectiformis* (Breidl.) Loeske
Native	Liverwort	*Tritomaria polita* (Nees) Jörg.
Native	Liverwort	*Tritomaria quinquedentata* (Huds.) H. Buch
Native	Liverwort	*Tritomaria scitula* (Taylor) Joerg.
Native	Moss	*Abietinella abietina* (Hedw.) M.Fleisch.
Native	Moss	*Andreaea blyttii* Schimp.

Native	Moss	*Andreaea nivalis* Hook.
Native	Moss	*Andreaea rupestris* Hedw.
Native	Moss	*Andreaea sinuosa* B.M.Murray
Native	Moss	*Antitrichia curtipendula* (Timm ex Hedw.) Brid.
Native	Moss	*Aongstroemia longipes* (Sommerf.) Bruch & Schimp.
Native	Moss	*Aulacomnium palustre* (Hedw.) Schwägr.
Native	Moss	*Barbula* sp.
Native	Moss	*Bartramia pomiformis* Hedw.
Native	Moss	*Batramia ithyphylla* Brid.
Native	Moss	*Brachythecium ? udum* I.Hagen
Native	Moss	*Brachythecium erythrorhizon* Schimp.
Native	Moss	*Brachythecium frigidum* (Müll. Hal.) Besch.
Native	Moss	*Brachythecium rivulare* Schimp.
Native	Moss	Bryaceae unknown
Native	Moss	*Buckiella undulata* (Hedw.) Ireland
Native	Moss	*Bucklandiella heterosticha* (Hedw.) Bednarek-Ochyra & Ochyra
Native	Moss	*Bucklandiella sudetica* (Funck) Bednarek-Ochyra & Ochyra
Native	Moss	*Calliergon cordifolium* (Hedw.) Kindb.
Native	Moss	*Campylium protensum* (Brid.) Kindb.
Native	Moss	*Campylium stellatum* (Hedw.) C.E.O. Jensen
Native	Moss	*Campylophyllum halleri* (Sw. ex Hedw.) M.Fleisch.
Native	Moss	*Ceratodon purpureus* (Hedw.) Brid.
Native	Moss	*Cinclidium stygium* Sw.
Native	Moss	*Climacium dendroideus* (Hedw.) F.Weber & D.Mohr
Native	Moss	*Codriophorus fascicularis* (Hedw.) Bednarek-Ochyra & Ochyra
Native	Moss	*Cratoneuron filicinum* (Hedw.) Spruce
Native	Moss	*Cynodontium tenellum* (Schimp.) Limpr.
Native	Moss	*Dichodontium pellucidum* (Hedw.) Schimp.
Native	Moss	*Dicranella varia* (Hedw.) Schimp.
Native	Moss	*Dicranodontium ? uncinatum* (Harv.) A.Jaeger
Native	Moss	*Dicranoweisia crispula* (Hedw.) Milde
Native	Moss	*Dicranum ? groenlandicum* Brid.
Native	Moss	*Dicranum elongatum* Schleich. ex Schwägr.
Native	Moss	*Dicranum howellii* Renauld & Cardot
Native	Moss	*Dicranum pallidisetum* (J.W. Bailey) Ireland
Native	Moss	*Dicranum scoparium* Hedw.
Native	Moss	*Didymodon fallax* (Hedw.) R.H. Zander
Native	Moss	*Didymodon rigidulus* Hedwig var. *rigidulus*
Native	Moss	*Didymodon rigidulus var. gracilis* (Schleich. ex Hook. & Grev.) R.H.Zander
Native	Moss	*Didymodon rigidulus* var. *icmadophilus* (Schimp. ex Müll. Hal.) R.H. Zander
Native	Moss	*Didymodon tophaceus* (Brid.) Lisa

Native	Moss	*Distichium capillaceum* (Hedw.) Bruch & Schimp.
Native	Moss	*Ditrichum flexicaule* (Schwägr.) Hampe
Native	Moss	*Ditrichum gracile* (Mitt.) Kuntze
Native	Moss	*Eurhynchiastrum pulchellum* (Hedw.) Ignatov & Huttunen
Native	Moss	*Gemmabryum caespiticium* (Hedw.) J.R.Spence
Native	Moss	*Gemmabryum dichotomum* (Hedw.) J.R. Spence & H.P. Ramsay
Native	Moss	*Grimmia atrata* Miel. ex Hornsch.
Native	Moss	*Grimmia donniana* Sm.
Native	Moss	*Grimmia elongata* Kaulf.
Native	Moss	*Heterocladium dimorphum* (Brid.) Schimp.
Native	Moss	*Homalothecium aeneum* (Mitt.) E. Lawton
Native	Moss	*Hygrohypnum duriusculum* (De Not.) D.W.Jamieson
Native	Moss	*Hygrohypnum luridum* (Hedw.) Jenn.
Native	Moss	*Hygrohypnum molle* (Hedw.) Loeske
Native	Moss	*Hygrohypnum ochraceum* (Turner ex Wilson) Loeske
Native	Moss	*Hylocomium splendens* (Hedw.) Schimp.
Native	Moss	*Hypnum circinale* Hook.
Native	Moss	*Hypnum subimponens* Lesq.
Native	Moss	*Imbribryum gemmiparum* (De Not.) J.R. Spence? (needs verification)
Native	Moss	*Isothecium stoloniferum* Brid.
Native	Moss	*Kiaeria blyttii* (Bruch & Schimp.) Broth.
Native	Moss	*Kiaeria falcata* (Hedw.) I. Hagen
Native	Moss	*Lescuraea baileyi* (Best & Grout) E.Lawton
Native	Moss	*Mielichhoferia elongata* (Hoppe & Hornsch.) Nees & Hornsch.
Native	Moss	*Mielichhoferia mielichhoferiana* (Funck) Loeske
Native	Moss	*Mnium marginatum* (Dicks. ex With.) P.Beauv.
Native	Moss	*Myurella julacea* (Schwägr.) Schimp.
Native	Moss	*Niphotrichum canescens* ssp. *latifolium* (C.E.O.Jens.) Frisvoll
Native	Moss	*Niphotrichum elongatum* (Ehrh. ex Frisvoll) Bednarek-Ochyra & Ochyra
Native	Moss	*Niphotrichum ericoides* (Brid.) Bednarek-Ochyra & Ochyra
Native	Moss	*Niphotrichum muticum* (Kindb.) Bednarek-Ochyra & Ochyra
Native	Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra
Native	Moss	*Oligotrichum parallelum* (Mitt.) Kindb.
Native	Moss	*Oncophorus virens* (Hedw.) Brid.
Native	Moss	*Oncophorus wahlenbergii* Bridel
Native	Moss	*Orthotrichum obtusifolium* Brid.
Native	Moss	*Orthotrichum pulchellum* Brunt.
Native	Moss	*Orthotrichum rupestre* Schleich. ex Schwägr.
Native	Moss	*Orthotrichum speciosum* Nees
Native	Moss	*Palustriella falcata* (Brid.) Hedenäs
Native	Moss	*Paraleucobryum enerve* (Thed.) Loeske
Native	Moss	*Philonotis fontana* var. *fontana* (Hedw.) Brid.
Native	Moss	*Plagiomnium ciliare* (Müll.Hal.) T.J.Kop.

Native	Moss	*Plagiomnium medium* (Bruch & Schimp.) T.J. Kop.
Native	Moss	*Plagiothecium cavifolium* (Brid.) Z.Iwats.
Native	Moss	*Plagiothecium piliferum* (Sw.) Schimp.
Native	Moss	*Platydictya jungermannioides* (Brid.) H.A.Crum
Native	Moss	*Pleurozium schreberi* (Willd. ex Brid.) Mitt.
Native	Moss	*Pogonatum contortum* (Brid.) Lesq.
Native	Moss	*Pogonatum urnigerum* (Hedwig) P.Beauv.
Native	Moss	*Pohlia cardotii* (Renauld) Broth.
Native	Moss	*Pohlia cruda* (Hedw.) S.O. Lindberg
Native	Moss	*Pohlia drummondii* (Müll. Hal.) Andrews
Native	Moss	*Pohlia erecta* (Limpr.) H.Lindb.
Native	Moss	*Pohlia filum* (Schimp.) Mårtensson
Native	Moss	*Pohlia nutans* (Hedw.) S.O. Lindberg
Native	Moss	*Pohlia pacifica* A.J.Shaw
Native	Moss	*Pohlia vexans* (Limpr.) H.Lindb.
Native	Moss	*Pohlia wahlenbergii* (F. Weber & D. Mohr) A.L. Andrews
Native	Moss	*Polytrichastrum alpinum* Hedw.) G.L.Sm. var*. alpinum*
Native	Moss	*Polytrichastrum alpinum var. sylvaticum* (Menzies) G.L.Sm.
Native	Moss	*Polytrichum commune* Hedw.
Native	Moss	*Polytrichum juniperinum* Hedw.
Native	Moss	*Polytrichum piliferum* Hedw.
Native	Moss	*Pseudoleskea atricha* (Kindb.) Kindb.
Native	Moss	*Pseudoleskea incurvata* (Hedw.) Loeske var. *incurvata*
Native	Moss	*Pseudoleskea patens* (Lindb.) Kindb.
Native	Moss	*Ptilidium pulcherrimum* (Weber) Hampe
Native	Moss	*Ptychostomum creberrimum* (Taylor) J.R.Spence & H.P.Ramsay
Native	Moss	*Ptychostomum inclinatum* (Sw. ex Brid.) J.R.Spence
Native	Moss	*Ptychostomum pallens* (Sw.) J.R. Spence
Native	Moss	*Ptychostomum pallescens* (Schleich. ex Schwägr.) J.R. Spence
Native	Moss	*Ptychostomum pendulum* Hornsch.
Native	Moss	*Ptychostomum turbinatum* (Hedw.) J.R.Spence
Native	Moss	*Ptychostomum weigelii* (Spreng.) J.R.Spence
Native	Moss	*Racomitrium lanuginosum* (Hedw.) Brid.
Native	Moss	*Rhizomnium magnifolium* (Horik.) T.J.Kop..
Native	Moss	*Rhizomnium nudum* (R.S. Williams) T.J. Kop.
Native	Moss	*Rhizomnium punctatum* (Hedw.) T.J.Kop.
Native	Moss	*Rhynchostegium aquaticum* A.Jaeger
Native	Moss	*Rhytidiadelphus loreus* (Hedw.) Warnst.
Native	Moss	*Rhytidiadelphus subpinnatus* (Lindb.) T.J.Kop.
Native	Moss	*Rhytidiadelphus triquetrus* (Hedw.) Warnst.
Native	Moss	*Rhytidiopsis robusta* (Hook.) Broth.
Native	Moss	*Rhytidium rugosum* (Hedw.) Kindb.
Native	Moss	*Sanionia georgico-uncinata* (Müll. Hal.) Ochyra & Hedenäs

Native	Moss	*Sanionia uncinata* (Hedw.) Loeske
Native	Moss	*Schistidium ? frisvollianum* H.H.Blom
Native	Moss	*Schistidium ? strictum* (Turner) Loeske ex Mårtensson
Native	Moss	*Schistidium agassizii* Sull. & Lesq.
Native	Moss	*Schistidium apocarpum* (Hedw.) Bruch & Schimp.
Native	Moss	*Schistidium frigidum* H.H. Blom
Native	Moss	*Schistidium rivulare* (Brid.) Podp.
Native	Moss	*Schistidium subjulaceum* H.H.Blom
Native	Moss	*Schistidium venetum* H.H.Blom
Native	Moss	*Sciurohypnum hylotapetum* (N. Higinbotham & B. Higinbotham) Ignatov & Huttunen
Native	Moss	*Sciurohypnum latifolium* (Kindb.) Ignatov & Huttunen
Native	Moss	*Scorpidium revolvens* (Sw.) Rubers
Native	Moss	*Sphagnum angustifolium* (Warnst.) C.E.O. Jensen
Native	Moss	*Sphagnum capillifolium* (Ehrh.) Hedw.
Native	Moss	*Sphagnum fuscum* (Schimp.) H.Klinggr.
Native	Moss	*Sphagnum squarrosum* Crome
Native	Moss	*Sphagnum teres* (Schimp.) Ångström
Native	Moss	*Syntrichia norvegica* F.Weber
Native	Moss	*Tayloria lingulata* (Dicks.) S.O. Lindberg
Native	Moss	*Thuidium recognitum* (Hedw.) Lindb.
Native	Moss	*Tortella fragilis* (Hook. & Wilson) Limpr.
Native	Moss	*Tortella tortuosa* (Hedwig) Limpricht var. *tortuosa*
Native	Moss	*Ulota megalospora* Venturi
Native	Moss	*Ulota obtusiuscula* Müller Hal. & Kindb.
Native	Moss	*Warnstorfia exannulata* (Schimp.) Loeske
Native	Moss	*Warnstorfia fluitans* (Hedw.) Loeske
Native	Vascular plant	*Abies lasiocarpa* (Hook.) Nutt.
Native	Vascular plant	*Acer glabrum* Torr.
Native	Vascular plant	*Achillea borealis* Bong.
Native	Vascular plant	*Achillea sudetica* Opiz
Native	Vascular plant	*Aconitum delphiniifolium* DC.
Exotic	Vascular plant	*Actium* sp. (leaf only)
Native	Vascular plant	*Adiantum aleuticum* (Rupr.) C.A.Paris
Native	Vascular plant	*Agoseris aurantiaca* (Hook.) E. Greene ssp. *aurantiaca* (Coast Ranges form)
Native	Vascular plant	*Agoseris aurantiaca* (Hook.) E. Greene ssp. *aurantiaca* (grassy-leaved form)
Native	Vascular plant	*Agrostis exarata* Trin.
Exotic	Vascular plant	*Agrostis gigantea* Roth
Native	Vascular plant	*Agrostis scabra* Willd.
Native	Vascular plant	*Alnus alnobetula* ssp. *fruticosa* (Rupr.) Raus
Native	Vascular plant	*Alnus alnobetula* ssp. *sinuata* (Regel) Raus

Native	Vascular plant	*Alnus rubra* Bong.
Native	Vascular plant	*Anaphalis margaritacea* (L.) Benth.
Native	Vascular plant	*Anemone multifida* Poir.
Native	Vascular plant	*Anemone narcissiflora var. monantha* DC.
Native	Vascular plant	*Anemone narcissiflora var. vilosissima* (DC.) Hultén
Native	Vascular plant	*Anemone parviflora* Michx.
Native	Vascular plant	*Angelica lucida* L.
Native	Vascular plant	*Antennaria alpina* (L.) Gaertn.
Native	Vascular plant	*Antennaria monocephala* ssp. *angustata* (E. Greene) Hultén
Native	Vascular plant	*Antennaria monocephala* ssp. *monocephala* DC.
Native	Vascular plant	*Aquilegia formosa* Fisch. ex DC.
Native	Vascular plant	*Arabidopsis lyrata* ssp. *kamchatica* (Fisch. ex DC.) O'Kane & Al-Shehbaz
Native	Vascular plant	*Arabis eschscholtziana* Andrz.
Native	Vascular plant	*Arctostaphylos uva-ursi* (L.) Spreng.
Native	Vascular plant	*Arnica frigida* C.A.Mey. ex Iljin
Native	Vascular plant	*Arnica latifolia* Bong.
Native	Vascular plant	*Arnica mollis* Hook.
Native	Vascular plant	*Artemisia norvegica* ssp. *saxatilis* (Besser) H.M.Hall & Clem.
Native	Vascular plant	*Aruncus dioicus* (Walter) Fernald
Native	Vascular plant	*Askellia pygmaea* (Ledeb.) Sennikov
Native	Vascular plant	*Asplenium trichomanes ssp. quadrivalens*(D.E.Meyer)
Native	Vascular plant	*Asplenium viride* Huds.
Native	Vascular plant	*Astragalus alpinus*L.
Native	Vascular plant	*Athyrium americanum* (Butters) Maxon
Native	Vascular plant	*Athyrium filix-femina* (L.) Roth
Native	Vascular plant	*Bistorta vivipara* (L.) Delarbre
Native	Vascular plant	*Boechera stricta* (Graham) Al-Shehbaz
Native	Vascular plant	*Botrychium crenulatum* W.H.Wagner
Native	Vascular plant	*Botrychium lunaria* (L.) Sw.
Native	Vascular plant	*Botrychium spathulatum* W.H.Wagner
Native	Vascular plant	*Botrychium tunux* Stensvold & Farrar
Native	Vascular plant	*Botrychium yaaxudakeit* Stensvold & Farrar
Native	Vascular plant	*Calamagrostis canadensis* (Michx.) P. Beauv.
Native	Vascular plant	*Caltha leptosepala* DC.
Native	Vascular plant	*Campanula lasiocarpa* Cham.
Native	Vascular plant	*Campanula rotundifolia* L.
Native	Vascular plant	*Canadanthus modestus* (Lindl.) G.L.Nesom
Native	Vascular plant	*Cardamine bellidifolia* L.
Native	Vascular plant	*Cardamine occidentalis* (S.Watson ex B.L.Rob.) Howell
Native	Vascular plant	*Cardamine oligosperma* Nutt.
Native	Vascular plant	*Carex anthoxanthea* J.Presl & C.Presl
Native	Vascular plant	*Carex arctiformis* Mack.
Native	Vascular plant	*Carex atrata* L. cfr.

Native	Vascular plant	*Carex brunnescens* ssp. *sphaerostachya* (Tuck.) Kalela
Native	Vascular plant	*Carex hoodii* Boott
Native	Vascular plant	*Carex macrochaeta* C.A. Mey.
Native	Vascular plant	*Carex mertensii* J.D. Prescott ex Bong.
Native	Vascular plant	*Carex micropoda* C.A. Mey.
Native	Vascular plant	*Carex nardina* Fr.
Native	Vascular plant	*Carex nigricans* C.A. Mey.
Native	Vascular plant	*Carex pauciflora* Lightf.
Native	Vascular plant	*Carex phaeocephala* Piper
Native	Vascular plant	*Carex scirpoidea var. pseudoscirpoidea* (Rydb.) Cronquist
Native	Vascular plant	*Carex sitchensis* Prescott ex Bong.
Native	Vascular plant	*Carex tahoensis* Smiley
Native	Vascular plant	*Cassiope lycopodioides* (Pall.) D.Don
Native	Vascular plant	*Cassiope mertensiana* (Bong.) G. Don
Native	Vascular plant	*Castilleja fulva* Pennell
Native	Vascular plant	*Castilleja parviflora* Bong. var. *parviflora*
Native	Vascular plant	*Castilleja rhexiifolia* Rydb.
Native	Vascular plant	*Cerastium arvense* L.
Native	Vascular plant	*Cerastium beeringianum* Auct. non Cham. & Schltdl.
Native	Vascular plant	*Cinna latifolia* (Trevir.) Griseb.
Native	Vascular plant	*Circaea alpina* L. *var. alpina*
Native	Vascular plant	*Cirsium edule var. macounii* (Greene) D.J.Keil
Native	Vascular plant	*Clintonia uniflora* (Menzies ex Schult. & Schult. f.) Kunth
Native	Vascular plant	*Comarum palustre* L.
Native	Vascular plant	*Cornus stolonifera* Michx.
Native	Vascular plant	*Cornus unalaschkensis* Ledeb.
Native	Vascular plant	*Cryptogramma acrostichoides* R. Br.
Native	Vascular plant	*Cryptogramma sitchensis* (Rupr.) T.Moore
Native	Vascular plant	*Cystopteris fragilis* (L.) Bernh.
Exotic	Vascular plant	*Dactylis glomerata* L.
Native	Vascular plant	*Dactylorhiza viridis* (L.) R.M.Bateman, Pridgeon & M.W.Chase
Native	Vascular plant	*Diphasiastrum alpinum* (L.) Holub
Native	Vascular plant	*Diphasiastrum sitchense* (Rupr.) Holub
Native	Vascular plant	*Draba ? cana* Rydb.
Native	Vascular plant	*Draba albertina* Greene
Native	Vascular plant	*Draba aurea* Vahl ex Hornem.
Native	Vascular plant	*Draba thompsonii* (C.L.Hitchc.) G.A.Mulligan & Al-Shehbaz
Native	Vascular plant	*Dryas drummondii* Richardson ex Hook.
Native	Vascular plant	*Dryopteris carthusiana* (Vill.) H.P.Fuchs
Native	Vascular plant	*Dryopteris expansa* (C.Presl) Fraser-Jenk. & Jermy
Native	Vascular plant	*Dryopteris filix-mas* (L.) Schott
Native	Vascular plant	*Elliottia pyroliflora* (Bong.) S.W.Brim & P.F.Stevens
Native	Vascular plant	*Elymus glaucus* Buckley ssp. *glaucus*

Native	Vascular plant	*Elymus glaucus ssp. virescens* (Piper) Gould
Native	Vascular plant	*Elymus glaucus x hirsutus*
Native	Vascular plant	*Elymus hirsutus* J.Presl
Native	Vascular plant	*Elymus trachycaulus* ssp. *trachycaulus* (Link) Gould ex Shinners
Native	Vascular plant	*Elymus violaceus* (Hornem.) J.Feilberg
Native	Vascular plant	*Empetrum nigrum* L.
Native	Vascular plant	*Epilobium anagallidifolium* Lam.
Native	Vascular plant	*Epilobium angustifolium* L.
Native	Vascular plant	*Epilobium ciliatum* ssp. *ciliatum* Raf.
Native	Vascular plant	*Epilobium ciliatum* ssp. *glandulosum* (Lehm.) Hoch & P.H. Raven
Native	Vascular plant	*Epilobium clavatum* Trel.
Native	Vascular plant	*Epilobium hornemannii* ssp. *behringianum* (Hausskn.) Hoch & P.H. Raven
Native	Vascular plant	*Epilobium hornemannii* ssp. *hornemannii* Rchb.
Native	Vascular plant	*Epilobium lactiflorum* Hausskn.
Native	Vascular plant	*Epilobium latifolium* L.
Native	Vascular plant	*Epilobium leptocarpum* Hausskn.
Native	Vascular plant	*Equisetum arvense* L.
Native	Vascular plant	*Equisetum fluviatile* L.
Native	Vascular plant	*Equisetum palustre* L.
Native	Vascular plant	*Equisetum variegatum* Schleich. ex F. Weber & D. Mohr var. *variegatum*
Native	Vascular plant	*Equisetum variegatum var. alaskanum* (A.A.Eaton) Hultén
Native	Vascular plant	*Erigeron humilis* Graham
Native	Vascular plant	*Erigeron nivalis* Nutt.
Native	Vascular plant	*Eriophorum angustifolium* Honck.
Native	Vascular plant	*Euphrasia anopta* Björk ined.
Native	Vascular plant	*Euphrasia celata* Björk ined.
Native	Vascular plant	*Fauria crista-galli* (Griseb.) Makino
Native	Vascular plant	*Festuca brachyphylla* Schult. & Schult. f.
Native	Vascular plant	*Festuca saximontana* var. *purpusiana* (St-Yves) Fred. & Pavlick
Native	Vascular plant	*Fritillaria kamtschatcensis* Torr.
Exotic	Vascular plant	*Galeopsis bifida* Boenn.
Native	Vascular plant	*Galium triflorum* Michx.
Native	Vascular plant	*Gentiana glauca* Pall.
Native	Vascular plant	*Gentianella propinqua* ssp. *propinqua* (Richardson) J.M. Gillett
Native	Vascular plant	*Geranium erianthum* DC.
Native	Vascular plant	*Geum macrophyllum* Willd. var. *macrophyllum*
Native	Vascular plant	*Glyceria borealis* (Nash) Batch.
Native	Vascular plant	*Gymnocarpium disjunctum* (Rupr.) Ching
Native	Vascular plant	*Gymnocarpium jessoense* (Koidz.) Koidz.
Native	Vascular plant	*Gymnocarpium* x *intermedium* Sarvela
Native	Vascular plant	*Harrimanella stelleriana* (Pall.) Coville

Native	Vascular plant	*Heracleum lanatum* Michx.
Native	Vascular plant	*Heuchera glabra* Willd. ex Roem. & Schult.
Native	Vascular plant	*Heuchera micrantha* var. *diversifolia* (Rydb.) Rosend., Butters & Lakela
Native	Vascular plant	*Hieracium albiflorum* Hook.
Native	Vascular plant	*Hieracium triste* Willd. ex Spreng.
Native	Vascular plant	*Hierochloe alpina* (Sw. ex Willd.) Roem. & Schult.
Native	Vascular plant	*Hippuris vulgaris* L.
Native	Vascular plant	*Huperzia arctica* (Grossh. ex Tolm.) Sipliv.
Native	Vascular plant	*Huperzia miyoshiana* (Makino) Ching
Native	Vascular plant	*Hypopitys monotropa* Crantz
Native	Vascular plant	*Juncus drummondii* E. Mey.
Native	Vascular plant	*Juncus mertensianus* Bong.
Native	Vascular plant	*Juncus tenuis* Willd.
Native	Vascular plant	*Juniperus communis* L.
Native	Vascular plant	*Kalmia microphylla* (Hook.) A. Heller
Native	Vascular plant	*Kalmia procumbens* (L.) Gift & Kron ex Galasso, Banfi & F.Conti
Native	Vascular plant	*Leptarrhena pyrolifolia* (D. Don) R. Br. ex Ser.
Native	Vascular plant	*Lloydia serotina* var. *serotina* (L.) Salisb. ex Rchb.
Native	Vascular plant	*Luetkea pectinata* (Pursh) Kuntze
Native	Vascular plant	*Lupinus fruticosus* (Sims) Björk comb. ined.
Native	Vascular plant	*Lupinus nootkatensis* Donn ex Sims
Native	Vascular plant	*Luzula arcuata* (Wahlenb.) Sw.
Native	Vascular plant	*Luzula parviflora* (Ehrh.) Desv.
Native	Vascular plant	*Luzula piperi* (Coville) M.E. Jones
Native	Vascular plant	*Luzula spicata* (L.) DC.
Native	Vascular plant	*Luzula wahlenbergii* Rupr.
Native	Vascular plant	*Lycopodium clavatum* L.
Native	Vascular plant	*Lycopodium lagopus* (Laestadius ex C.Hartman) G.Zinserling ex Kuzeneva-Prochorova
Native	Vascular plant	*Lysichiton americanus* Hultén & St.John
Native	Vascular plant	*Maianthemum racemosum* (L.) Link
Native	Vascular plant	*Menyanthes trifoliata* L.
Native	Vascular plant	*Menziesia ferruginea* Sm.
Native	Vascular plant	*Micranthes ferruginea* var. *macounii* (Engler & Irmsch.) Björk comb. ined.
Native	Vascular plant	*Micranthes lyallii* (Engl.) Small
Native	Vascular plant	*Micranthes porsildiana* (Calder & Savile) Elven & D.F.Murray
Native	Vascular plant	*Micranthes separata*Björk ined.
Native	Vascular plant	*Micranthes tolmiei* (Torr. & A. Gray) Brouillet & Gornal
Native	Vascular plant	*Minuartia biflora* (L.) Schinz & Thell.
Native	Vascular plant	*Minuartia rubella* (Wahlenb.) Hiern
Native	Vascular plant	*Moneses uniflora* A.Gray
Exotic	Vascular plant	*Mycelis muralis* (L.) Dumort.

Native	Vascular plant	*Myosotis alpestris* F.W.Schmidt s. lat.
Native	Vascular plant	*Nabalus alatus* Hook.
Native	Vascular plant	*Neottia banksiana* Rchb. f.
Native	Vascular plant	*Neottia convallarioides* Rich.
Native	Vascular plant	*Neottia nephrophylla* (Rydb.) Szlach.
Native	Vascular plant	*Nuphar variegatum* Engelm.
Native	Vascular plant	*Oenanthe sarmentosa* C.Presl ex DC.
Native	Vascular plant	*Oplopanax horridus* (Sm.) Miq.
Native	Vascular plant	*Orthilia secunda* (L.) House
Native	Vascular plant	*Osmorhiza berteroi* DC.
Native	Vascular plant	*Osmorhiza purpurea* (J.M. Coult. & Rose) Suksd.
Native	Vascular plant	*Oxyria digyna* (L.) Hill
Native	Vascular plant	*Packera paupercula* (Michx.) Á.Löve & D.Löve
Native	Vascular plant	*Parnassia fimbriata* K.D. Koenig
Native	Vascular plant	*Pectiantia pentandra* (Hook.) Rydb.
Native	Vascular plant	*Pedicularis ornithorhyncha* Benth.
Native	Vascular plant	*Pedicularis sudetica var. interior* Hultén
Native	Vascular plant	*Petasites nivalis* E. Greene
Native	Vascular plant	*Phleum alpinum* L.
Native	Vascular plant	*Phyllodoce glanduliflora* (Hook.) Coville
Native	Vascular plant	*Picea glauca* (Moench) Voss
Native	Vascular plant	*Picea sitchensis* (Bong.) Carriére
Exotic	Vascular plant	*Plantago major* L.
Native	Vascular plant	*Platanthera dilatata* var. *dilatata* (Pursh) Lindl. ex L.C. Beck
Native	Vascular plant	*Platanthera huronensis* Lindl.
Native	Vascular plant	*Platanthera huronensis x stricta*
Native	Vascular plant	*Platanthera stricta* Lindl.
Native	Vascular plant	*Platismatia glauca* (L.) W. L. Culb. & C. F. Culb.
Native	Vascular plant	*Platismatia norvegica* (Lynge) W.L.Culb. & C.F.Culb.
Native	Vascular plant	*Poa alpina* L.
Exotic	Vascular plant	*Poa annua* L.
Native	Vascular plant	*Poa arctica* ssp. *arctica* R. Br.
Native	Vascular plant	*Poa glauca* ssp. *pekulnejensis* (Yurtsev & Tzvelev) Prob.
Native	Vascular plant	*Poa glauca* ssp. *rupicola* (Nash) W.A. Weber
Native	Vascular plant	*Poa leptocoma* Trin.
Native	Vascular plant	*Poa palustris* L.
Native	Vascular plant	*Poa paucispicula* Scribn. & Merr.
Native	Vascular plant	*Poa pratensis* L. (native form)
Native	Vascular plant	*Poa pratensis* ssp. *colpodea* (Th. Fr.) Tzvelev
Native	Vascular plant	*Podagrostis aequivalvis* (Trin.) Scribn. & Merr.
Native	Vascular plant	*Polypodium glycyrrhiza* D.C.Eaton
Native	Vascular plant	*Polypodium glycyrrhiza x hesperium*
Native	Vascular plant	*Polypodium hesperium* Maxon

Native	Vascular plant	*Polystichum andersonii* Hopkins
Native	Vascular plant	*Polystichum lonchitis* (L.) Roth
Native	Vascular plant	*Populus trichocarpa* Torr. & A.Gray
Native	Vascular plant	*Potamogeton epihydrus* Raf.
Native	Vascular plant	*Potamogeton natans* L.
Native	Vascular plant	*Potamogeton pusillus* L.
Native	Vascular plant	*Potentilla arenosa* (Turcz.) Juz.
Native	Vascular plant	*Potentilla glaucophylla* Lehm. var. *glaucophylla*
Native	Vascular plant	*Potentilla hyparctica* var. *elatior* (Abrom.) Fernald
Native	Vascular plant	*Potentilla norvegica* L.
Native	Vascular plant	*Potentilla villosa* Pallas ex Pursh
Native	Vascular plant	*Potentilla villosula* Jurtzev
Native	Vascular plant	*Prunella vulgaris* ssp. *lanceolata* (W.P.C.Barton) Piper & Beattie
Native	Vascular plant	*Pyrola asarifolia* Michx.
Native	Vascular plant	*Ranunculus aquatilis* L. group
Native	Vascular plant	*Ranunculus cooleyae*Vasey & Rose ex Rose
Native	Vascular plant	*Ranunculus eschscholtzii* Schltdl.
Native	Vascular plant	*Ranunculus occidentalis* Nutt. *var. nov.*
Native	Vascular plant	*Ranunculus occidentalis* var. *hexasepalus* L.D. Benson
Native	Vascular plant	*Ranunculus pygmaeus* Wahlenb.
Exotic	Vascular plant	*Ranunculus repens* L.
Native	Vascular plant	*Ranunculus uncinatus* D.Don
Native	Vascular plant	*Rhodiola integrifolia* Raf.
Native	Vascular plant	*Ribes bracteosum* Douglas ex Hooker
Native	Vascular plant	*Ribes lacustre* (Pers.) Poir.
Native	Vascular plant	*Ribes laxiflorum* Pursh
Native	Vascular plant	*Romanzoffia sitchensis* Bong.
Native	Vascular plant	*Rubus idaeus* L.
Native	Vascular plant	*Rubus parviflorus* Nutt.
Native	Vascular plant	*Rubus pedatus* Sm.
Native	Vascular plant	*Rubus spectabilis* Pursh
Native	Vascular plant	*Rumex obtusifolius* L.
Native	Vascular plant	*Sagina saginoides* (L.) H. Karst.
Native	Vascular plant	*Salix* aff. *arctica* Pall.
Native	Vascular plant	*Salix alaxensis* var. *alaxensis* (Anderss.) Coville
Native	Vascular plant	*Salix alaxensis* var. *longistylis* (Rydb.) C.K. Schneid.
Native	Vascular plant	*Salix arctica* Pall.
Native	Vascular plant	*Salix barrattiana* Hook.
Native	Vascular plant	*Salix drummondiana* Barratt ex Hook.
Native	Vascular plant	*Salix glauca* L.
Native	Vascular plant	*Salix lasiandra* Benth.
Native	Vascular plant	*Salix petrophila* Rydb.
Native	Vascular plant	*Salix reticulata* L.

Native	Vascular plant	*Salix scouleriana* Barratt ex Hook.
Native	Vascular plant	*Salix sitchensis* Sanson ex Bong.
Native	Vascular plant	*Salix stolonifera* Coville
Native	Vascular plant	*Salix* unknown 1 (low red-fruited)
Native	Vascular plant	*Salix* unknown 2 (medium-sized, green fruited)
Native	Vascular plant	*Sambucus callicarpa* Greene
Native	Vascular plant	*Sanguisorba sitchensis* C.A.Meyer
Native	Vascular plant	*Saxifraga aizoides* L.
Native	Vascular plant	*Saxifraga cespitosa* L.
Native	Vascular plant	*Saxifraga oppositifolia* ssp. *smalliana* (Engl. & Irmsch.) Hultén
Native	Vascular plant	*Saxifraga tricuspidata* Rottb.
Native	Vascular plant	*Sedum divergens* S. Watson
Native	Vascular plant	*Selaginella scopulorum* Maxon
Native	Vascular plant	*Senecio triangularis* Hook.
Native	Vascular plant	*Sibbaldia procumbens* L.
Native	Vascular plant	*Silene acaulis* (L.) Jacq.
Native	Vascular plant	*Solidago multiradiata* Aiton
Native	Vascular plant	*Sorbus sitchensis* M. Roem.
Native	Vascular plant	*Sparganium emersum* Rehm.
Native	Vascular plant	*Sparganium minimum* L.
Native	Vascular plant	*Stellaria calycantha* (Ledeb.) Bong.
Native	Vascular plant	*Stellaria crispa* Cham. & Schltdl.
Native	Vascular plant	*Stellaria sitchana* Steud.
Native	Vascular plant	*Streptopus amplexifolius* (L.) DC.
Native	Vascular plant	*Streptopus lanceolatus* var. *curvipes* (Vail) Reveal
Native	Vascular plant	*Streptopus streptopoides* (Ledeb.) Frye & Rigg
Native	Vascular plant	*Taraxacum amarum* Björk ined.
Native	Vascular plant	*Taraxacum argilliticola* Björk ined.
Exotic	Vascular plant	*Taraxacum aurulosum* H.Lindb.
Native	Vascular plant	*Taraxacum cordilleranum* Björk ined.
Native	Vascular plant	*Taraxacum lautellum* Björk ined.
Exotic	Vascular plant	*Taraxacum retroflexum* H.Lindb.
Exotic	Vascular plant	*Taraxacum scanicum* Dahlst.
Native	Vascular plant	*Taraxacum* sp. 4 (blackish cypselae)
Native	Vascular plant	*Taraxacum sp. nov.* (short, narrow sinuses)
Native	Vascular plant	*Taraxacum sp. nov.* (tall, same as T. speculorum?)
Native	Vascular plant	*Taraxacum speculorum* Björk ined.
Native	Vascular plant	*Tellima grandiflora* (Pursh) Douglas ex Lindl.
Native	Vascular plant	*Tiarella trifoliata* L.
Native	Vascular plant	*Trientalis arctica* Fisch. ex Hook.
Exotic	Vascular plant	*Trifolium repens* L
Native	Vascular plant	*Trisetum canescens* Buckley
Native	Vascular plant	*Trisetum spicatum* (L.) K. Richt.

Native	Vascular plant	*Tsuga heterophylla* (Raf.) Sarg.
Native	Vascular plant	*Tsuga mertensiana* (Bong.) Carrière
Native	Vascular plant	*Urtica gracilis* Aiton
Native	Vascular plant	*Vaccinium alaskense* Howell
Native	Vascular plant	*Vaccinium caespitosum* Michx.
Native	Vascular plant	*Vaccinium membranaceum* Douglas ex Torr.
Native	Vascular plant	*Vaccinium ovalifolium* Sm.
Native	Vascular plant	*Vaccinium uliginosum* L.
Native	Vascular plant	*Vahlodea atropurpurea* (Wahlenb.) Fr. ex Hartm.
Native	Vascular plant	*Valeriana sitchensis* Bong.
Native	Vascular plant	*Veratrum viride* Aiton
Native	Vascular plant	*Veronica nutans* Bong.
Native	Vascular plant	*Veronica serpyllifolia* L.
Native	Vascular plant	*Viola glabella* Nutt.
Native	Vascular plant	*Viola langsdorfii* Fisch. ex Ging.
Native	Vascular plant	*Viola palustris* L.
Native	Vascular plant	*Woodsia alpina* (Bolton) A. Gray
Native	Vascular plant	*Woodsia glabella* R.Br.
Native	Vascular plant	*Woodsia ilvensis* (L.) R.Br.

APPENDIX K. SUMMARY OF RARE PLANT AND LICHEN LOCATIONS AND HABITAT

Life form	Taxon	BC rank or other significance	Field photo?	Specimen?	Collection # (all collections by Björk)	Herbarium	Date observed	Zone	UTM E	UTM N	Source of coordinates
Lichen	*Collema ceraniscum* Nyl.	S1 Red	No	Yes	*Bj örk 42272*	UBC	2016, August 9	9V	455124	6201411	GPS unit
Moss	*Pohlia erecta* (Limpr.) H.Lindb.	S1 Red	No	Yes	*Bj örk 42179*	UBC	2016, July 6	9V	455847	6200652	GPS unit
Lichen	*Stereocaulon botryosum* Ach.	S2 Red	Yes	Yes	*Bj örk 42309*	UBC	2016, August 9	9V	455522	6201354	GPS unit
Lichen	*Santessoniella arctophila* (Th.Fr.) Henssen	S1 Red	Yes	Yes	*Bj örk 42288*	UBC	2016, August 9	9V	455235	6201411	GPS unit
Lichen	*Stereocaulon botryosum* Ach.	S2 Red	Yes	Yes	*Bj örk 42328*	UBC	2016, August 9	9V	455519	6201504	GPS unit
Moss	*Mielichhoferia elongata* (Hoppe & Hornsch.) Nees & Hornsch.	S1S2 Red	Yes	Yes	*Bj örk 42406*	UBC	2016, August 9	9V	453904	6201543	GPS unit
Moss	*Mielichhoferia mielichhoferiana* (Funck) Loeske	S2 Red	Yes	Yes	*Bj örk 42400*	UBC	2016, August 9	9V	453904	6201543	GPS unit
Lichen	*Bryoria nitidula* (Th. Fr.) Brodo & D. Hawksw.	S2S3 Blue	No	None	N/A	N/A	2016, July 6	9V	455483	6201557	GPS unit
Lichen	*Cetraria nigricans* Nyl.	S3 Blue	No	Yes	*Bj örk 42419*	UBC	2016, August 9	9V	455311	6201604	GPS unit
Moss	*Grimmia atrata* Miel. ex Hornsch.	New discovery for British Columbia, known to be a rare species elsewhere	No	Yes	*Bj örk 42389*	UBC	2016, August 9	9V	453813	6201708	GPS unit
Moss	*Schistidium venetum* H.H.Blom	S1 Red	No	Yes	*Bj örk 42396*	UBC	2016, August 9	9V	453813	6201708	GPS unit
Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra	S3 Blue	No	Yes	*Bj örk 42404*	UBC	2016, August 9	9V	453813	6201713	GPS unit
Moss	*Imbribryum gemmiparum* (De Not.) J.R. Spence? (needs verification)	S2S3 Blue	Yes	Yes	*Bj örk 42345*	UBC	2016, August 9	9V	455618	6201713	GPS unit
Moss	*Cinclidium stygium* Sw.	S3 Blue	No	Yes	*Bj örk 42164*	UBC	2016, July 6	9V	452666	6204310	GPS unit
Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra	S3 Blue	No	Yes	*Bj örk 42170*	UBC	2016, July 6	9V	452673	6204330	GPS unit
Lichen	*Stereocaulon botryosum* Ach.	S2 Red	Yes	Yes	*Bj örk 42157*	UBC	2016, July 8	9V	452673	6204330	GPS unit
Lichen	*Cladonia macrophylla* (Schaer.) Stenh.	S2 Red	Yes	Yes	*Bj örk 42150*	UBC	2016, July 7	9V	452352	6204815	GPS unit
Lichen	*Cladonia coccifera* (L.) Willd.	S1 Red	No	Yes	*Bj örk 42527*	UBC	2016, July 8	9V	452185	6205014	GPS unit
Vascular plant	*Botrychium crenulatum* W.H.Wagner	S2S3 Blue	Yes	Yes	*Bj örk 41156*	UBC	2016, July 8	9V	452186	6205014	GPS unit
Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra	S3 Blue	Yes	Yes	*Bj örk 42224*	UBC	2016, July 8	9V	452004	6205173	GPS unit
Lichen	*Fuscopannaria ahlneri* (P.M.Jørg.) P.M.Jørg.	S2S3 Blue	Yes	Yes	*Bj örk 42457, 42460*	UBC	2016, August 10	9V	452228	6205706	GPS unit

Life form	Taxon	BC rank or other significance	Field photo?	Specimen?	Collection # (all collections by Björk)	Herbarium	Date observed	Zone	UTM E	UTM N	Source of coordinates
Lichen	*Leptogidium dendriscum* (Nyl.) Nyl.	S3 Blue	No	None	N/A	N/A	2016, August 10	9V	452228	6205706	GPS unit
Vascular plant	*Taraxacum* sp. nov. (short)	Newly discovered species, not represented among any previous herbarium specimens, hence likely to be rare	Yes	Yes	*Bj örk 41139*	UBC	2016, July 7	9V	446340	6205918	GPS unit
Vascular plant	*Botrychium spathulatum* W.H.Wagner	S3 Blue	Yes	Yes	*Bj örk 41136*	UBC	2016, July 7	9V	446306	6205952	GPS unit
Lichen	*Umbilicaria lambii* Imshaug	S3 Blue	Yes	None	N/A	N/A	2016, July 7	9V	450130	6206199	GPS unit
Vascular plant	*Taraxacum speculorum* Björk ined.	Newly discovered species, not represented among any previous herbarium specimens, hence likely to be rare	Yes	Yes	*Björk 41119*	UBC	2016, July 7	9V	450088	6206292	GPS unit
Lichen	*Lobaria retigera* (Bory) Trevis.	S3 Blue	Yes	None	N/A	N/A	2016, July 5	9V	448689	6208986	GPS unit
Lichen	*Santessoniella arctophila* (Th.Fr.) Henssen	S1 Red	Yes	Yes	*Bj örk 42123*	UBC	2016, July 5	9V	449572	6207037	GPS unit
Moss	*Pohlia pacifica* A.J.Shaw	S1S2 Red	No	Yes	*Bj örk 42448*	UBC	2016, August 10	9V	449018	6209191	GPS unit
Moss	*Ptychostomum inclinatum* (Sw. ex Brid.) J.R.Spence	S3 Blue	No	Yes	*Bj örk 42444*	UBC	2016, August 10	9V	449018	6209191	GPS unit
Lichen	*Baeomyces carneus* Flörke	S1 Red	No	Yes	*Bj örk 42426*	UBC	2016, August 10	9V	452714	6210438	GPS unit
Lichen	*Leptogium tenuissimum* (Dicks.) Körb.	S2? Red	No	Yes	*Bj örk 42430*	UBC	2016, August 10	9V	452714	6210438	GPS unit
Lichen	*Placynthium asperellum* (Ach.) Trevisan	S3? Blue	No	Yes	*Bj örk 42425*	UBC	2016, August 10	9V	452714	6210438	GPS unit
Lichen	*Collema crispum* (Hudson) F. H. Wigg. cfr.	S1 Red	No	Yes	*Bj örk 42526*	UBC	2016, August 11	9V	443815	6211818	GPS unit
Lichen	*Heterodermia* unknown sp.	A species not previously noted from North America	Yes	Yes	*Bj örk 42524*	UBC	2016, August 11	9V	443815	6211818	GPS unit
Moss	*Grimmia donniana* Sm.	S2S3 Blue	No	Yes	*Bj örk 42331*	UBC	2016, August 9	9V	455586	6201634	GPS unit

Life form	Taxon	BC rank or other significance	Field photo?	Specimen?	Collection # (all collections by Björk)	Herbarium	Date observed	Zone	UTM E	UTM N	Source of coordinates
Vascular plant	*Micranthes separata* Björk ined.	An undescribed species that appears to be rare, limited to the BC Coast Ranges, known from < 10 sites	Yes	Yes	*Bj örk 41166*	UBC	2016, July 8	9V	446615	6208512	Used Google Earth and the GPS track, no waypoint taken, position on the aerial photo obvious by the habitat
Vascular plant	*Taraxacum* sp. nov. (tall)	Newly discovered species, not represented among any previous herbarium specimens, hence likely to be rare	Yes	Yes	*Bj örk 41123*	UBC	2016, July 7	9V	446340	6205918	GPS unit
Liverwort	*Peltolepis quadrata* (Saut.) K.Müller	S2 Red	Yes	Yes	*Bj örk 42206, 42209*	UBC	2016, July 7	9V	446433	6205941	GPS unit
Liverwort	*Sauteria alpina* (Nees) Nees	S3 Blue	Yes	Yes	*Bj örk 42210*	UBC	2016, July 7	9V	446433	6205941	GPS unit
Liverwort	*Nardia compressa* (Hook.) Gray	S3 Blue	Yes	Yes	*Bj örk 42240*	UBC	2016, August 8	9V	455381	6201802	GPS unit
Moss	*Pohlia cardotii* (Renauld) Broth.	S3 Blue	Yes	Yes	*Bj örk 42122*	UBC	2016, July 5	9V	449639	6207507	GPS unit
Vascular plant	*Taraxacum amarum* Björk ined.	Newly discovered species, not represented among any previous herbarium specimens, hence likely to be rare	Yes	Yes	*Bj örk 41089, 41092*	UBC	2016, July 6	9V	452339	6204642	GPS unit
Lichen	*Cladonia pseudalcicornis* Asahina	S2S3 Blue	No	Yes	*Bj örk 42562*	UBC	2016, July 6	9V	455471	6201837	GPS unit
Lichen	*Nephroma isidiosum* (Nyl.) Gyeln.	S3 Blue	No	Yes	*Bj örk 42528*	UBC	2016, July 8	9V	452185	6205014	GPS unit
Lichen	*Lobaria oregana* (Tuck.) Müll.Arg.	S3 Blue	No	Yes	*Bj örk 42139*	UBC	2016, July 7	9V	448689	6208986	GPS unit
Vascular plant	*Anemone narcissiflora var. vilosissima* (DC.) Hultén	S1S3 Red	Yes	None	N/A	N/A	2016, July 7	9V	446340	6205918	GPS unit
Vascular plant	*Anemone narcissiflora var. vilosissima* (DC.) Hultén	S1S3 Red	Yes	Yes	*Bj örk 41103*	UBC	2016, July 6	9V	447747	6211838	GPS unit

Life form	Taxon	Habitat description	Population size	Population area	Mapping instructions
Lichen	*Collema ceraniscum* Nyl.	Terricolous, alpine tundra	1 thallus	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Pohlia erecta* (Limpr.) H.Lindb.	Short cliff, alpine ridge, silcieous rock	1 small patch of thalli	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Stereocaulon botryosum* Ach.	On stone in alpine tundra	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Santessoniella arctophila* (Th.Fr.) Henssen	On stone in alpine tundra	1 small patch of thalli	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Stereocaulon botryosum* Ach.	Terricolous, alpine tundra	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Mielichhoferia elongata* (Hoppe & Hornsch.) Nees & Hornsch.	On gossen within a large calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Mielichhoferia mielichhoferiana* (Funck) Loeske	On gossen within a large calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Bryoria nitidula* (Th. Fr.) Brodo & D. Hawksw.	On gossen, alpine	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Cetraria nigricans* Nyl.	Alpine heath	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Grimmia atrata* Miel. ex Hornsch.	Calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Schistidium venetum* H.H.Blom	Calcareous gabbro outcrop	Unknown	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra	Calcareous gabbro outcrop	1 patch noted	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Imbribryum gemmiparum* (De Not.) J.R. Spence? (needs verification)	Moist ground, alpine, along rivulets	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Cinclidium stygium* Sw.	On calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra	On calcareous gabbro outcrop	1 patch noted	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Stereocaulon botryosum* Ach.	On calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Cladonia macrophylla* (Schaer.) Stenh.	Calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Cladonia coccifera* (L.) Willd.	Calcareous gabbro outcrop	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Vascular plant	*Botrychium crenulatum* W.H.Wagner	Outcrop of high-pH ultramaphic rock, brushy with Alnus alnobetula (mostly)	2 stems	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Niphotrichum pygmaeum* (Frisvoll) Bednarek-Ochyra & Ochyra	Calcareous gabbro outcrop	1 patch noted	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Fuscopannaria ahlneri* (P.M.Jørg.) P.M.Jørg.	Stem Alnus, young dediduous forest in gully, calcareous soil	50-100 thalli	<1 x 1 m	Map as a single point with a 5 m radial buffer

Life form	Taxon	Habitat description	Population size	Population area	Mapping instructions
Lichen	*Leptogidium dendriscum* (Nyl.) Nyl.	Twig Picea in mostly deciuous forest in gully	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Vascular plant	*Taraxacum* sp. nov. (short)	On rich, loamy soil, saddle on alpine ridge	ca. 10 plants	<1 x 1 m	Map as a single point with a 5 m radial buffer
Vascular plant	*Botrychium spathulatum* W.H.Wagner	Sloped meadow, alpine, rich soil	3 stems	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Umbilicaria lambii* Imshaug	On siliceous boulder, alpine ridge	2 patches	<1 x 1 m	Map as a single point with a 5 m radial buffer
Vascular plant	*Taraxacum speculorum* Björk ined.	On mound of loamy soil at upper edge of erosion slope and fine scree	ca. 10 plants	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Lobaria retigera* (Bory) Trevis.	On tsuga twig in old growth forest	1 thallus	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Santessoniella arctophila* (Th.Fr.) Henssen	Terricolous, subalpine	1 small patch of thalli	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Pohlia pacifica* A.J.Shaw	Sandy portion of large cobble bar along swift-flowing creek	Unknown	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Ptychostomum inclinatum* (Sw. ex Brid.) J.R.Spence	Sandy portion of large cobble bar along swift-flowing creek	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Baeomyces carneus* Flörke	Cliff, moderately calcareous, friable argillite, alpine	1 thallus	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Leptogium tenuissimum* (Dicks.) Körb.	Cliff, moderately calcareous, friable argillite, alpine	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Placynthium asperellum* (Ach.) Trevisan	Cliff, moderately calcareous, friable argillite, alpine	1 patch	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Collema crispum* (Hudson) F. H. Wigg. cfr.	Trunk Populus by lake shore, nitrogen-enriched by adjacent outhouse	<10 thalli on a single tree	<1 x 1 m	Map as a single point with a 5 m radial buffer
Lichen	*Heterodermia* unknown sp.	Trunk Populus by lake shore, nitrogen-enriched by adjacent outhouse	6 thalli	<1 x 1 m	Map as a single point with a 5 m radial buffer
Moss	*Grimmia donniana* Sm.	On siliceous rock, alpine, along rivulets	1 patch noted	<1x 1 m	Map as a single point with a 5 m radial buffer

Appendix K. Summary of Rare Plant and Lichen Locations and Habitat

Life form	Taxon	Habitat description	Population size	Population area	Mapping instructions
Vascular plant	*Micranthes separata* Björk ined.	At base of seepage, toe position of avelanche track at shore of large creek	20-30 plants	10 x 10 m	Map as a single point with a 20 m radial buffer
Vascular plant	*Taraxacum* sp. nov. (tall)	On rich, loamy soil, saddle on alpine ridge	5-10 plants	2 x 2 m	Map as a single point with a 10 m radial buffer
Liverwort	*Peltolepis quadrata* (Saut.) K.Müller	Alpine ridge, near glacier, argillite and intrusive volcanic rocks	200-300 thalli	ca. 10 x 10 m	Map as a single point with a 20 m radial buffer
Liverwort	*Sauteria alpina* (Nees) Nees	Alpine ridge, near glacier, argillite and intrusive volcanic rocks	100-200 thalli	ca. 10 x 10 m	Map as a single point with a 20 m radial buffer
Liverwort	*Nardia compressa* (Hook.) Gray	Along mineral spring outflow in alpine heath	ca. 50 patches	ca. 5 x 20 m	Population should be mapped as a polygon that outlines the mineral spring habitat (visible on aerial photos as a white streak), the buffer around this feature should be 5 m.
Moss	*Pohlia cardotii* (Renauld) Broth.	Terricolous by small pool in subalpine grove	500-1000 stems	ca. 5 x 5 m	Map as a single point with a 10 m radial buffer
Vascular plant	*Taraxacum amarum* Björk ined.	Shallow soil, seepage on large outcrop complex of ultramaphic rock with high pH	ca. 100-150 plants	Exact bounds unknown, but the species occurs sporadically throughout the Bromley Humps	Population bounds should correspond to the open rocky areas of the Bromley Humps
Lichen	*Cladonia pseudalcicornis* Asahina	Alpine heath	Unknown	Population bounds unknown	
Lichen	*Nephroma isidiosum* (Nyl.) Gyeln.	On Picea twig in chasm between rock outcrops	Unknown	Unknown	Map as a single point with a 5 m radial buffer
Lichen	*Lobaria oregana* (Tuck.) Müll.Arg.	On windfall twig, humid forest	Unknown	Unknown	Map as a single point with a 100 m radial buffer
Vascular plant	*Anemone narcissiflora var. vilosissima* (DC.) Hultén	On rich, loamy soil, saddle on alpine ridge	>1,000	Unknown population bounds	Map as a single point with a 50 m radial buffer
Vascular plant	*Anemone narcissiflora var. vilosissima* (DC.) Hultén	Steeply sloped alpine meadow	>10,000	Unknown population bounds	Map as a single point with a 100 m radial buffer