

# 18. Assessment of Potential Wildlife Effects

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## 18.1 INTRODUCTION

The effects assessment for wildlife of the Brucejack Gold Mine Project (the Project) describes the objectives of relevant land use plans (Section 18.2), existing wildlife and wildlife habitat in a wildlife Regional Study Area (RSA; Section 18.3), and the spatial and temporal boundaries of the assessment (Section 18.4.2). Baseline study reports are located in [Appendices 18-A](#), 2013 Wildlife Characterization Baseline Report, and [18-B](#), 2013 Wildlife Habitat Suitability Report. The list of Valued Components (VCs) and the potential effects on these VCs raised by Aboriginal peoples, government regulators, regional planning strategies, and scientific research are listed in Sections 18.4 and 18.5, respectively. Residual effects on each wildlife VC are addressed in a separate section of this chapter (Section 18.6). Each VC section is subdivided by the potential effects deemed to be of concern for that VC. Where issues are directly and indirectly linked, sections are cross-referenced to avoid redundancy.

The assessment then evaluates the significance of the residual effects on each wildlife VC (Section 18.7), summarizes the residual effects on wildlife VCs (Section 18.8), and provides a cumulative effects assessment (CEA) which combines the potential residual effects of the Project with other residual effects of human activities in this region (Section 18.9). A summary of the effects assessment results and conclusions are presented at the end of this chapter in Section 18.10.

## 18.2 REGULATORY AND POLICY FRAMEWORK

### 18.2.1 Wildlife Legislation

The British Columbia Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO) Region 6 (Skeena) manages wildlife in the region. The Pacific/Yukon Region of Environment Canada is the federal agency responsible for wildlife and species at risk in the region. Wildlife and wildlife habitat are protected under several federal and provincial acts, including the:

- *Canada Migratory Birds Convention Act* (1994);
- *Canada Species at Risk Act* (SARA; 2002c);
- *British Columbia (BC) Wildlife Act* (1996);
- *BC Mines Act* (1996b);
- *Canadian Biodiversity Strategy* (Environment Canada 1995);
- *BC Environmental Management Act* (2003);
- *BC Forest and Range Practices Act* (FRPA; 2002b); and
- *BC Water Act* (1996c).

The *Canada Migratory Birds Convention Act* (1994) prohibits the killing of migratory birds or depositing harmful substances in areas frequented by migratory birds, and also protects their eggs and nests. SARA provides federal legal protection and prevents SARA-listed wildlife species from becoming extinct, and secures the necessary actions for their recovery. Section 34 of the *Wildlife Act* (1996) protects most vertebrate animals from direct harm and harassment and specifically protects birds, eggs, and occupied nests from possession, molestation, injury, or destruction. The *Mines Act* (1996b) includes provisions for reclamation and restoration of habitat, including monitoring for metals in the

environment. The Canadian Biodiversity Strategy (Environment Canada 1995) provides guidance on the topics of conservation and sustainable use, ecological management and education. The BC component of the strategy focuses on protecting biodiversity and informed the need to conduct particular surveys to estimate the richness and location of certain diverse groups of wildlife species, such as birds. The BC Environmental Management Act (2003) regulates the discharge of wastes into the environment from certain prescribed industries.

Under the FRPA, areas that are important or critical to ungulates and sensitive wildlife, such as Ungulate Winter Ranges (UWRs) and Wildlife Habitat Areas (WHAs), are protected and managed for forest and range practices. General Wildlife Management Measures are established for UWRs and WHAs, which include regulations such as prohibiting road construction and/or disturbance within established buffers around UWR and/or WHA boundaries, unless an exemption is provided. The BC *Water Act* (1996c) entitles its permit holder to construct fences, screens, or game guards across streams to conserve wildlife.

The RSA (Sections 18.3.3.3 and 18.4.2.1) overlaps three Wildlife Management Units (WMUs) within Skeena Region 6: WMUs 6-16, 6-21, and minor portions of 6-17. A provincially designated mountain goat winter range order (#U-6-002) contains habitat polygons that overlap many areas of the RSA (BC MOE 2008). Preliminary provincial WHAs for grizzly bear and UWRs for moose have been proposed within the RSA. There are no caribou or Stone's sheep UWRs within the RSA.

The RSA also lies partially within the Nass Area as defined in the *Nisga'a Final Agreement* (2000). Under the NFA (2000), moose, mountain goat and grizzly bear have been identified as initial designated species for which there are specific Nisga'a allocations (Chapter 25; Section 25.3.4.2). Hunting and trapping of non-designated species continues in accordance with traditional practices and as set out in the *Nisga'a Fish and Wildlife Act* (2012b). Nisga'a people have traditionally trapped fur-bearing mammals, including marmot, fisher, marten, mink, and weasel, although the level of trapping activity may be in decline (Rescan 2012).

Standards and best management practices are guiding statements that allow development to occur in a way that will avoid, limit, or mitigate effects on aquatic and riparian habitats, water quality and quantity, fish and wildlife species, and public safety and property. Standards are defined as regulatory requirements that must be followed or achieved in the design and completion of developments (BC MWLAP 2004f). Best management practices are recommended methods or techniques that should be followed to ensure the standards are met and effects are mitigated. Best management practices and guidelines relevant to the Project include, but are not limited to:

- *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in BC* (BC MWLAP 2004b);
- *Best Management Practices for Raptor Conservation during Urban and Rural Land Development in BC* (BC MWLAP 2005; M. W. Demarchi, Bentley, and Sopuck 2005)
- *Migratory Birds Environmental Assessment Guideline* (Milko 1998a);
- *BC Environmental Assessment Guidelines for Grizzly Bears and Black Bears* (MacHutchon 2001);
- *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in BC* (BC MOE 2006a);
- *Environmental Best Management Practices for Urban and Rural Land Development: Special Wildlife and Species at Risk* (BC MOE 2004);
- *Wildlife Guidelines for Backcountry Tourism/Commercial Recreation* (BC MOE 2006c);

- *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (APLIC 2006);
- *Standards and Best Practices for Instream Works* (BC MWLAP 2004f);
- *Wetlands Environmental Assessment Guideline* (Milko 1998b);
- *Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in BC* (WSP 2009); and
- *Nisga'a Final Agreement* (2000).

### 18.2.2 Land Management Plans

The Project is within the Regional District of Kitimat-Stikine, and contains extensive areas of Crown land and areas that are subject to the Cassiar Iskut-Stikine Land and Resource Management Plan (CIS LRMP; BC ILMB 2000) in the northwest of the RSA, and the Nass South Sustainable Resource Management Plan (SRMP; BC MFLNRO 2012) in the southwest of the RSA. Wildlife-related management objectives of both the CIS LRMP and the Nass South SRMP are described in Table 18.2-1. A substantial area within the eastern portion of the RSA is without a strategic land management plan.

**Table 18.2-1. Wildlife Objectives of the Cassiar Iskut-Stikine Land and Resource Management Plan and Nass South Sustainable Resource Management Plan**

Management Direction	Wildlife-related Resource	Wildlife-related Management Objectives
<b>CIS LRMP (BC ILMB 2000)</b>		
General Management Direction - Access Management	Access Management	<ul style="list-style-type: none"> <li>• Minimize impacts on wildlife habitat and sensitive ecosystems during road construction and use.</li> <li>• Manage game populations by controlling hunting and fishing access, where required.</li> <li>• Provide access for long-term resource management and economic development needs while minimizing impacts on environmental, social, cultural heritage, and wildlife habitat values and commercial activities.</li> <li>• Minimize disturbance to wildlife due to aircraft use, particularly during sensitive periods.</li> </ul>
	Aquatic Ecosystems and Riparian Habitat	<ul style="list-style-type: none"> <li>• Conserve riparian habitat by minimizing disturbance to the structural and functional features of riparian habitat, including critical habitat features.</li> </ul>
	Endangered Plants and Animals	<ul style="list-style-type: none"> <li>• Maintain habitats of rare, threatened, and endangered animals, plants, and plant communities as described in the BC Conservation Data Centre lists.</li> <li>• Maintain habitat of fisher where populations are known to exist.</li> <li>• Maintain nesting and foraging habitat for nest sites of raptors, particularly rare and endangered species, including northern goshawk, short-eared owl, gyrfalcon, peregrine falcon.</li> <li>• Minimize disturbance of critical habitat areas for trumpeter swans (e.g., nesting and over-wintering areas, including early spring migration stops).</li> </ul>
	Special Landforms: Plateaus	<ul style="list-style-type: none"> <li>• Minimize impacts of motorized activities on plateaus and their habitats.</li> <li>• Maintain connectivity for wildlife between plateaus and adjacent plateaus and mountain ranges.</li> </ul>
General Management Direction - Biodiversity/ Ecosystem Health	Wildlife: General	<ul style="list-style-type: none"> <li>• Maintain habitat to support healthy wildlife populations.</li> <li>• Manage development and access to conserved important habitat features and wildlife.</li> </ul>

(continued)

**Table 18.2-1. Wildlife Objectives of the Cassiar Iskut-Stikine Land and Resource Management Plan and Nass South Sustainable Resource Management Plan (continued)**

Management Direction	Wildlife-related Resource	Wildlife-related Management Objectives
<b>CIS LRMP (BC ILMB 2000) (cont'd)</b>		
General Management Direction - Biodiversity/ Ecosystem Health (cont'd)	Wildlife: Moose	<ul style="list-style-type: none"> <li>Maintain functional integrity of moose winter range by maintaining critical habitat features (i.e., thermal and snow interception cover, winter forage, and visual screening), and by managing harvesting activities to minimize the impact on winter habitat.</li> </ul>
	Wildlife: Caribou	<ul style="list-style-type: none"> <li>Maintain large areas of high value caribou habitat including spring, summer, and winter habitat by maintaining the integrity of important habitat characteristics such as forests with lichen, areas of contiguous mature and old forest, and wetland complexes.</li> <li>Maintain the functional integrity of mapped caribou winter range, with particular reference to the Three Sisters, Kehlechoa River, and the Stikine. Also address the range north and east of Spatsizi Park by maintaining winter forage opportunities and snow interception cover, and managing access and harvesting activities to minimize effects on winter habitat.</li> </ul>
	Wildlife: Mountain Goat and Stone's Sheep	<ul style="list-style-type: none"> <li>Maintain large areas of high value Stone's sheep and mountain goat habitat and avoid disturbing animals during kidding and lambing.</li> <li>Maintain functional integrity of mapped winter range for mountain ungulates by maintaining critical habitat features (i.e., thermal and snow interception cover and winter forage), and by managing access to minimize impact to winter habitat.</li> </ul>
	Wildlife: Grizzly Bear	<ul style="list-style-type: none"> <li>Maintain large areas of high value habitat by maintaining areas of well-distributed, seasonally important habitats for grizzly bear across the landscape and through time.</li> <li>Reduce human-bear interactions.</li> <li>Manage hunting and other activities to limit bear mortality from all human causes to less than 4% of the estimated population so harvest of females does not exceed 30% of annual allowable harvest and the total kill is not area-concentrated.</li> <li>Minimize bear/human conflicts and disruption of bear habitat use.</li> <li>Monitor overall effectiveness of habitat management for grizzly bear.</li> </ul>
	Wildlife: Marten	<ul style="list-style-type: none"> <li>Maintain large areas of high value marten habitat by maintaining important habitat characteristics (i.e., forest structural attributes and mature and old forest providing interior forest conditions).</li> </ul>
Resource Management Zone - Unuk River Zone	General	<ul style="list-style-type: none"> <li>Maintain high-quality and quantity of grizzly bear habitat while allowing commercial timber harvesting and mineral exploration and development to occur.</li> </ul>
<b>Nass South SRMP (BC MFLNRO 2012)</b>		
Water Resources	Water	<ul style="list-style-type: none"> <li>Maintain ecological functioning of streams, rivers, wetland complexes and lakes, including those that do not support fish populations.</li> <li>Maintain the functional integrity of floodplains and alluvial fans.</li> </ul>
Biodiversity Resources	Biodiversity	<ul style="list-style-type: none"> <li>Maintain or recruit structural attributes of old forests to support stand-level biodiversity.</li> </ul>
Wildlife	Moose	<ul style="list-style-type: none"> <li>Maintain, enhance, or restore moose winter range habitats.</li> <li>Through access management, minimize mortality and disturbance to moose within and adjacent to the moose winter ranges identified.</li> </ul>

(continued)

**Table 18.2-1. Wildlife Objectives of the Cassiar Iskut-Stikine Land and Resource Management Plan and Nass South Sustainable Resource Management Plan (completed)**

Management Direction	Wildlife-related Resource	Wildlife-related Management Objectives
Nass South SRMP (BC MFLNRO 2012) ( <i>cont'd</i> )		
Wildlife ( <i>cont'd</i> )	Mountain Goat	<ul style="list-style-type: none"> <li>• Minimize adverse disturbance to goats within identified mountain goat winter range.</li> <li>• Minimize the number of roads within 500 m of winter range and 1,000 m of canyon-dwelling goat winter range.</li> <li>• Minimize adverse disturbance to mountain goat winter range from helicopter logging activities.</li> </ul>
	Grizzly Bear	<ul style="list-style-type: none"> <li>• Preserve the highest value grizzly bear habitat.</li> <li>• Maintain the quality and effectiveness of grizzly bear foraging habitat.</li> <li>• Minimize human-bear conflicts.</li> <li>• Minimize long-term displacement of grizzly bears from industrial access development.</li> </ul>
	Water	<ul style="list-style-type: none"> <li>• Maintain ecological functioning of streams, rivers, wetland complexes and lakes, including those that do not support fish populations.</li> <li>• Maintain the functional integrity of floodplains and alluvial fans.</li> </ul>
	Furbearers	<ul style="list-style-type: none"> <li>• Minimize impact to known high-value fisher and wolverine habitat.</li> </ul>
	Northern Goshawk	<ul style="list-style-type: none"> <li>• Maintain nesting and post-fledgling habitat at known goshawk nest areas, to support continued use and reproduction in those areas.</li> <li>• Maintain foraging habitat around known goshawk nest and post-fledgling areas.</li> </ul>
	General Wildlife	<ul style="list-style-type: none"> <li>• Maintain effectiveness of riparian habitats adjacent to wetlands.</li> </ul>

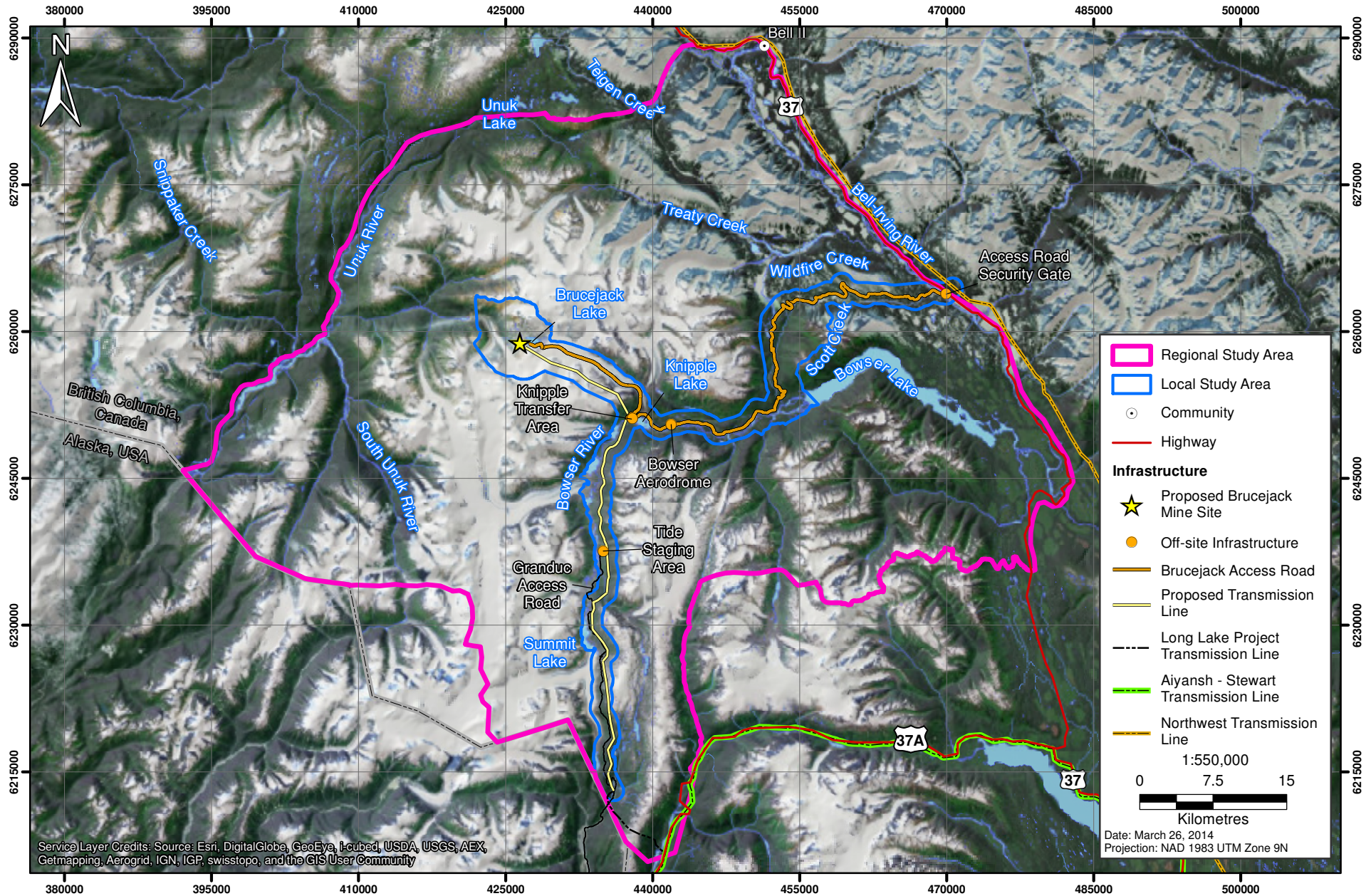
### 18.3 EXISTING ENVIRONMENT

This section provides an overview of wildlife associated with the Project and describes the following aspects:

- a regional overview (including regional ecology, protected areas, important wildlife habitat, species of conservation concern, and species of local interest);
- historical activities;
- an overview of wildlife baseline studies (including study objectives, data sources, methods, and the study areas); and
- wildlife characterization (including mammal, avian, and amphibian species groups).

Wildlife baseline information is presented for both a Local Study Area (LSA; 31,847 hectares [ha]) and an RSA (374,433 ha; Figure 18.3-1). The LSA and RSA defined the area for wildlife baseline studies and were modified in extent for the effects assessment when infrastructure layout was confirmed. Details on the boundaries of the baseline LSA and RSA, as well as a rationale for the extent and boundaries of these study areas, are presented in Section 18.3.3.3. Details on the boundaries of the effects assessment LSA and RSA and rationale for the extent of the boundaries are presented in Section 18.4.2.1.

**Figure 18.3-1**  
**Regional Study Area and Local Study Area for Wildlife Baseline Studies**



An initial series of wildlife VCs and methods for wildlife baseline surveys were developed in 2010 and 2011. Wildlife VCs selected for baseline surveys included mountain goat (*Oreamnos americanus*), moose (*Alces alces*), grizzly bear (*Ursus arctos*), bats, furbearers, hoary marmot (*Marmota caligata*), raptors, waterbirds, landbirds, and western toad (*Anaxyrus boreas*). Habitat suitability models were developed for mountain goat, moose, grizzly bear, black bear (*Ursus americanus*), fisher (*Pekania pennanti*), American marten (*Martes americana*), and hoary marmot. Wildlife habitat was mapped within the study areas according to provincial standards, included local knowledge wherever possible, was field-evaluated, and was conducted at an appropriate scale as determined regionally for each wildlife species (RIC 1999a). The wildlife baseline reports ([Appendices 18-A](#), 2013 Wildlife Characterization Baseline Report and [18-B](#), 2013 Wildlife Habitat Suitability Report) provide details on methods and results for wildlife characterization studies conducted from 2010 to 2013 for the Project. Following the baseline fieldwork, results from these reports were presented to government agencies in May and August 2013.

### 18.3.1 Regional Overview

#### 18.3.1.1 Regional Ecology

In order to present the regional ecological context in which the Project resides, the area is described using the BC Ecoregional Classification system and Biogeoclimatic Ecosystem Classification (BEC) system (D. A. Demarchi 1996; BC MOFR 2013). BEC uses the interactions of dominant vegetation, soils, and topography to identify geographic areas (biogeoclimatic zones and subzones) with a relatively uniform climate (BC MOFR 2013).

Ecoregions represent broad areas of major physiographic and minor macroclimatic variation. Within ecoregions, ecosections depict areas of minor physiographic and minor macroclimatic variation. The wildlife RSA is within three ecoregions: the Boundary Ranges, Skeena Mountains, and Nass Ranges. The Boundary Ranges Ecoregion extends towards the coast from the RSA, is dissected by several major river valleys, and includes the Nass Valley. This ecoregion includes the proposed Brucejack Mine Site, most of the western portion of the RSA, and the southern portion of the Brucejack Transmission Line.

Inland and east of the Boundary Ranges lies the Skeena Mountains Ecoregion, which consists of high, rugged mountains supporting many glaciers within the eastern RSA. The climate of the Nass Ranges Ecoregion is transitional between coastal and interior regimes (D. A. Demarchi 1996) and includes the eastern and central portions of the exploration access road within the LSA and the northern portion of the Brucejack Transmission Line.

Three ecosections are present in the Project region, including two within the Nass Ranges Ecoregion (the Meziadin Mountains and Nass Basin Ecosections), and one within the Boundary Ranges Ecoregion (the Southern Boundary Ranges Ecosection). The Meziadin Mountains Ecosection is a rugged, mountainous area on the leeward side of the main Boundary Ranges. Near Highway 37, the existing Brucejack Access Road crosses through the Nass Basin Ecosection, a basin of low relief encircled by sharply rising mountains including the Boundary Ranges to the west and the Skeena Mountains to the east. The western and southern areas associated with the Project cross into the Southern Boundary Ranges Ecosection, an area of wet rugged mountains that are capped with glaciers, small ice fields, and exposed granitic and metamorphic bedrock. The regional ecology in the RSA is further described in the Assessment of Potential Terrestrial Ecology Effects (Chapter 16, Section 16.3).

The BEC zones and subzones present within the RSA include Boreal Altai Fescue Alpine Undifferentiated and Parkland (BAFAunp), Coastal Mountain-heather Alpine Undifferentiated and Parkland (CMAunp), Coastal Western Hemlock Wet Maritime (CWHwm), Engelmann Spruce-Subalpine Fir Wet Very Cold (ESSFwv), Interior Cedar Hemlock Very Cold Wet (ICHvc), and Mountain Hemlock Leeward Moist

Maritime (MHmm2). These BEC zones and sub-zones present in the RSA are further described in the Assessment of Potential Terrestrial Ecology Effects (Chapter 16, Section 16.3).

Habitat types within the RSA and LSA are diverse, with mature and riparian forests, wetlands at lower elevations, and shrubs/stunted trees and drier sparsely-vegetated subalpine and alpine habitat at higher elevations. The major watersheds of the Bowser River, Bell-Irving River, Treaty Creek, and Unuk River support low elevation riparian forest and flood plain habitat, with large cottonwood and spruce stands that transition to subalpine fir and western hemlock forests as the slope and elevation increases. In total, 6,509 ha (1.7%) of the RSA comprises water, glaciers, rock outcrops, and sparsely vegetated alpine areas of the higher elevation parkland/krummholtz ecosystem which is typically found at elevations above 1,000 metres (m). In general, elevations in the RSA range from approximately 240 m above sea level (masl) at the confluence of Sulphurets Creek and the Unuk River, to over 2,300 masl at the peak of the Unuk Finger.

#### 18.3.1.2 Protected Areas

There is one provincially protected area in the RSA; Border Lake Provincial Park (800 ha), which is on the Unuk River at the extreme southwest corner of the RSA. Border Lake Provincial Park is 32.5 kilometres (km) from the Project footprint. The park includes a wetland complex associated with three lakes in the floodplain of the Unuk River valley (BC MWLAP 2003). It contains rare plant species, supports important fish habitat for Sockeye Salmon (*Oncorhynchus nerka*) and the anadromous cutthroat trout (*Oncorhynchus clarkii*), and has high value spring habitat for grizzly bear and nesting and forage habitat for waterbirds (BC MWLAP 2003). There is no drainage connection between Brucejack Lake and Border Lake Provincial Park; hydrological connection from the Brucejack Lake is to Brucejack Creek, Sulphurets Creek, and to Unuk River, while Border Lake flows down into Border Lake Creek, and into the Unuk River.

#### 18.3.1.3 Wildlife Habitats with Development Guidelines

A variety of wildlife habitats occur in the RSA that have been identified by provincial or scientific authorities as being important for wildlife in this area. Many of these habitats have development guidelines associated with them. These include: (1) sensitive habitats (riparian habitat, old-growth forests and alpine ecosystems) and (2) high-quality habitats and features (WHAs, UWRs, salmon spawning areas, mineral licks, and movement corridors).

#### Sensitive Habitats

These habitats consist of vegetation communities and wildlife habitat that are sensitive to disturbances and include riparian habitat, old-growth forests, and alpine ecosystems.

#### *Riparian Habitat*

Riparian habitats (including wetlands) provide high-quality denning and foraging habitat to a diverse wildlife community and serve as movement corridors for wildlife. An objective of the Unuk River Zone (a Resource Management Zone within the CIS LRMP) is to apply best management practices to wetlands, floodplains, and riparian habitat (BC ILMB 2000). The Unuk River Zone covers an area of 10,000 ha and lies south of Sulphurets Creek along the Unuk River valley on the western side of the RSA. The riparian habitat along the Unuk River, Treaty Creek, Bell-Irving River, and Bowser River supports salmon spawning habitat that is used by grizzly bears in the fall and that supports large cottonwood stands that are suitable for fisher natal dens. Wetlands are used by moose for rutting in the fall and overwintering in lower snowpack areas in the winter, and waterfowl nest in tree cavities or in sedge/grass meadows around these areas.

### *Old-growth Forests*

Old-growth forests are included in this category because of their structural diversity, supporting a wide variety of plant and animal species, such as winter habitat for ungulates through provision of thermal and snow interception cover; denning habitat for bears; roosting habitat for bats; nesting habitat for various bird species; and habitat for furbearers, such as American marten. Most of the RSA has not been harvested and valley bottoms support old-growth forests, except in the Bowser Lake area, where logging has occurred with access from Highway 37.

Old growth within the CWHwm and ICHvc BEC zones in moist and nutrient rich areas provide valuable habitat for wildlife. Mature and old forested riparian habitat, particularly cottonwood, supports black bear and fisher dens, and provides nesting, roosting, and feeding habitat for various other species. Project-related alterations to old-growth forests are evaluated in detail in Chapter 16, Assessment of Potential Terrestrial Ecology Effects.

Some old-growth areas are protected through the establishment of Old Growth Management Areas (OGMAs), which are permanent old-growth retention areas, reserved from forest development modification such as clearing, harvesting, and activities that may cause blow-down within the boundaries of the OGMA. These areas are established by the British Columbia Ministry of Forests through consultation with Aboriginal groups, the British Columbia Ministry of Environment (BC MOE)/BC MFLNRO, and other individuals. OGMAs are a component of most integrated resource management plans, and they contain legal objectives that are enforceable under the *Forest Range and Practices Act* (2002b) and the *Land Act* (1996a). In 1999, the Landscape Unit Planning Guide identified retention of old-growth forest as a priority for biodiversity planning (BC MOF and BC MELP 1999). No legislated OGMAs are present within the LSA or RSA. Three OGMAs have been proposed in the Nass South SRMP (BC MFLNRO 2012) that overlaps the southern portion of the RSA.

### *Alpine Ecosystems*

Alpine ecosystems are defined by a general absence of trees due to climatic and edaphic conditions associated with increases in elevation. Common ecosystems include heath heather, herb meadows, and krummholz. Non-vegetated areas, such as permanent snow, ice fields, rock outcrops, and barren soil, are common. Alpine vegetation is considered sensitive because disturbed vegetation may not recover to pre-disturbance levels, even in the long term (Frank and del Moral 1986; Forbes, Ebersole, and Strandberg 2001; Mingyu et al. 2009). Protecting alpine ecosystems is also a goal of the CIS LRMP (BC ILMB 2000).

Alpine ecosystems are important seasonal habitat for wildlife, providing forage, breeding areas, and escape terrain from predators and insects. For example, grizzly bear forage extensively in alpine and meadow areas in the summer and fall, and mountain goats use alpine areas for both winter habitat and movement corridors (McNay, MacDonald, and Giguere 2009).

### High-quality Wildlife Habitats and Features

High-quality wildlife habitat and features have been identified by provincial legislation, SRMPs, or LRMPs, and may have associated management objectives. These habitats include WHAs, UWRs, salmon spawning habitat, ungulate mineral licks, and movement corridors.

### *Wildlife Habitat Areas*

WHAs represent wildlife habitat considered for management under the Identified Wildlife Management Strategy (BC MWLAP 2004d). There are no designated WHAs for grizzly bear or fisher in the Skeena Region, but candidate grizzly bear WHA polygons (WHA 6-282) have been proposed along Treaty Creek, the Bell-Irving River, and Surveyors Creek. The candidate WHAs are within the eastern portion of the

RSA, with patches overlapping the exploration access road between Highway 37 and the western end of Bowser Lake.

### *Ungulate Winter Ranges*

UWRs, like WHAs, are established through a land use planning process and are defined by the BC MOE under the authority of sections 9(2) and 12(1) of the Government Actions Regulation (BC Reg. 582/2004) and the FRPA (2002b). UWRs ensure environmental sustainability across a landscape by: (1) identifying suitable habitat, and (2) integrating habitats that provide a variety of functions, including considerations for habitat interspersion (BC MFLNRO 2012). UWRs have legislated management strategies that include work timing windows and set-back distances for road construction and aircraft flying (BC MOE 2008). A designated mountain goat UWR (u-6-002) was established in December 2008 for the Nass Timber Supply Area (TSA) that overlaps the RSA and LSA. UWR u-6-002 includes polygons at high elevations near the Bowser River, the proposed transmission line route, along the access road, and throughout the RSA and LSA. Candidate UWRs for moose are proposed along the Bell-Irving River and Treaty Creek (UWR 6-018).

### *Salmon Spawning Areas*

Areas of particular importance to grizzly bears are salmon-bearing streams and spawning areas. During fisheries baseline studies, Coho salmon were present in all large watersheds of the Bell-Irving drainage, but not in the Unuk River, Todd Creek, or Scott Creek watersheds. Chinook salmon were only captured in the Bell-Irving River and Unuk River watersheds near or in the large mainstem rivers (Chapter 15, Assessment of Potential Fish and Fish Habitat Effects). Spawning sockeye and coho salmon were found in Todedada Creek and Bowser River. Sockeye salmon were observed in a branch of Todedada Creek, in a small tributary of the Bowser River, and in two groundwater-fed channels near the outlets of the Bowser River and Scott Creek to Bowser Lake. Spawning coho salmon were found in the greatest numbers within Todedada Creek (Chapter 15, Assessment of Potential Fish and Fish Habitat Effects). Other areas identified as important for salmon spawning include the lower Bowser River to its confluence with the Bell-Irving River, and the large floodplain associated with the Bell-Irving River and Teigen Creek drainages (M. W. Demarchi and Johnson 2000). Deoxyribonucleic acid (DNA) baseline studies on grizzly bears showed individual bears moving long distances, in one case across the RSA, to salmon-bearing streams in the Bell-Irving and Unuk rivers during the fall, presumably to feed on salmon (Rescan 2010a, 2013). The Canada *Fisheries Act* (1985) and the BC *Fish Protection Act* (1997) provides protection for fish and fish habitat as well as the protection of commercial, recreational, and Aboriginal fisheries.

### *Ungulate Mineral Licks*

Natural mineral licks are habitat features that are important for maintaining the health of ungulates. Mineral licks are important for mountain goats, which use licks primarily during the summer to compensate for mineral deficiencies or imbalances in their diet (Ayotte, Parker, and Gillingham 2008). A mineral lick may be designated as a Wildlife Habitat Feature and managed under the FRPA (2002b). These areas are likely used annually and are important for the local mountain goat population. One mineral lick was observed during baseline surveys in the RSA on the Snowslide Range, and a potential mineral lick was identified in the LSA near the proposed Brucejack Mine Site ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). The importance of these mineral licks to ungulates in the RSA is unknown.

### *Movement Corridors*

Movement corridors connect habitats that are exploited during different times of the year, while movements within daily or seasonal ranges may also occur along specific routes (e.g., pathways to mineral licks). Corridors increase animal movement between habitat patches, which can facilitate healthy population sizes, enable gene flow, and maintain biodiversity (Haddad et al. 2003). Migratory movements of moose, for example, often follow traditional routes, with animals using the same annual movement corridors (Bowyer, Ballenberghe, and Kie 2003). Moose and grizzly bear likely use the major

drainages in the RSA, such as the Bell-Irving, Treaty, Unuk, and Bowser drainages and the landscape features (e.g., saddles and riparian areas) which connect these valleys, when moving between their seasonal ranges. Observations of grizzly bear and mountain goat on high-elevation glaciers also suggest that these features facilitate movement between watersheds.

Within these movement corridors, the Skii km Lax Ha currently perform much of their hunting along a circular route that starts at Bowser Lake and ends at Awijii (at Skowill Creek, on the east side of the Bell-Irving River) proceeding along the north side of Mount Anderson and then down the Scott Creek/Treaty Creek valleys, back to the Bell-Irving River (Chapter 25; Figure 25.5-2). This harvesting area is plentiful in moose, grizzly bear and mountain goat. The Tahltan have also expressed concern about the potential effects of roads on the movement corridors for moose.

#### 18.3.1.4 *Species of Conservation Concern*

Species of conservation concern include species or populations federally listed as Endangered, Threatened, or of Special Concern as designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for SARA (COSEWIC 2013; SARA 2013). Provincially, species are designated on the red and blue lists by the BC MOE under the *Wildlife Act* (1996). Overall, 34 species of conservation concern were detected within the RSA or were considered as likely occurring (L) or possibly occurring (P) within the RSA, based on species distribution maps (Table 18.3-1). Five species that were confirmed within the RSA during baseline studies are listed on Schedule 1 of SARA: olive-sided flycatcher, rusty blackbird, short-eared owl, great-blue heron, and western toad.

#### 18.3.1.5 *Species or Groups of Local Interest*

Some wildlife species and groups within the LSA and/or RSA are identified as regionally important for biological, economic, social, or cultural reasons (Table 18.3-2). In addition, Identified Wildlife under the Government of BC Identified Wildlife Management Strategy (IWMS) were included as species of local interest, as they are species that have been acknowledged as important to regional stakeholder groups such as First Nations, government agencies, and other regional community members. Regionally important species or groups have been identified by biologists, Aboriginal peoples, local community members, and from information included in land and resource management documents, such as the LRMPs and SRMPs (see Section 18.2.2 for details of the land management plans).

### 18.3.2 **Historical and Current Activities**

Several historical and current human activities are within close proximity to the proposed Project Area and within the RSA. These include mining exploration and production, hydroelectric power generation, forestry and road construction and use, backcountry recreation, hunting, and trapping. Potential effects of interactions of wildlife with other proposed or existing projects are discussed in the CEA section for wildlife (Section 18.9).

#### 18.3.2.1 *Industrial Projects*

Industrial projects within the RSA (past and/or currently active) comprise the following: 1) Sulphurets underground exploration project; 2) Granduc copper mine; 3) Eskay Creek gold and silver mine; and 4) Long Lake hydroelectric project.

**Table 18.3-1. Species of Conservation Concern Potentially Occurring within the Wildlife Local Study Area and Regional Study Area**

Common Name	Scientific Name	Likelihood of Occurrence <sup>1</sup>	Conservation Status					
			Provincial Rank	BC List	Identified Wildlife <sup>2</sup>	COSEWIC	SARA	Global Rank
<b>Large Mammals</b>								
Northern Caribou	<i>Rangifer tarandus</i>	P	S3	Blue	Y	T/SC	1-SC	G5T5
Grizzly bear	<i>Ursus arctos</i>	C	S3	Blue	Y	SC		G4
<b>Furbearers</b>								
Fisher	<i>Martes pennant</i>	C	S2S3	Blue	Y			G5
Wolverine, <i>luscus</i> spp	<i>Gulo gulo luscus</i>	C	S3	Blue	Y	SC		G4T4
Least weasel	<i>Mustela nivalis</i>	L	S4	Yellow				G5
<b>Bats</b>								
Northern myotis	<i>Myotis septentrionalis</i>	L	S2S3	Blue		E		G4
Keen's myotis	<i>Myotis keenii</i>	P	S1S3	Red	Y	DD	3	G2G3
Little brown myotis	<i>Myotis lucifugus</i>	C	S5	Yellow		E		G5
<b>Raptors</b>								
Snowy owl	<i>Bubo scandiacus</i>	P	S3N	Blue		NAR		G5
Short-eared owl	<i>Asio flammeus</i>	C	S3B,S2N	Blue	Y	SC	1-SC	G5
Western screech-owl	<i>Megascops kennicottii kennicottii</i>	P	S3	Blue		T	1-SC	G5T4
Rough-legged hawk	<i>Buteo lagopus</i>	P	S2S3N	Blue		NAR		G5
Peregrine Falcon, <i>pealei</i> ssp	<i>Falco peregrinus pealei</i>	P	S3B	Blue		SC	1-SC	G4T3
Peregrine Falcon, <i>anatum</i> ssp	<i>Falco peregrinus anatum</i>	P	S2?B	Red		SC	1-T	G4T4
Gyr Falcon	<i>Falco rusticolus</i>	P	S3S4B	Blue		NAR		G5
Swainson's Hawk	<i>Buteo swainsoni</i>	P	S2B	Red				G5
<b>Waterbirds</b>								
Wandering tattler	<i>Tringa incana</i>	P	S3S4B	Blue				G5
Upland sandpiper	<i>Bartramia longicauda</i>	P	S1S2B	Red				G5
Great blue heron	<i>Ardea herodias fannini</i>	C	S2S3B,S4N	Blue		SC	1-SC	G5T4
Western grebe	<i>Aechmophorus occidentalis</i>	P	S1B,S2N	Red		C		G5
Horned grebe	<i>Podiceps auritus</i>	P	S4B	Yellow		SC		G5
Yellow-billed loon	<i>Gavia adamsii</i>	P	S2S3N	Blue		NAR		G4

(continued)

**Table 18.3-1. Species of Conservation Concern Potentially Occurring within the Wildlife Local Study Area and Regional Study Area (completed)**

Common Name	Scientific Name	Likelihood of Occurrence <sup>1</sup>	Conservation Status					
			Provincial Rank	BC List	Identified Wildlife <sup>2</sup>	COSEWIC	SARA	Global Rank
<b>Waterbirds (cont'd)</b>								
American bittern	<i>Botaurus lentiginosus</i>	P	S3B	Blue				G4
Red-necked phalarope	<i>Phalaropus lobatus</i>	P	S3S4B	Blue				G4G5
Tundra swan	<i>Cygnus columbianus</i>	C	S3N	Blue				G5
Surf scoter	<i>Melanitta perspicillata</i>	P	S3B,S4N	Blue				G5
American golden-plover	<i>Pluvialis dominica</i>	P	S3S4B	Blue				G5
<b>Landbirds</b>								
Sooty Grouse	<i>Dendragapus fuliginosus</i>	C	S3S4	Blue				G5
Olive-sided flycatcher	<i>Contopus cooperi</i>	C	S3S4B	Blue		T	1-T	G4
Barn swallow	<i>Hirundo rustica</i>	C	S3S4B	Blue	Y	T		G5
Rusty blackbird	<i>Euphagus carolinus</i>	C	S3S4B	Blue		SC	1-SC	G4
Common nighthawk	<i>Chordeiles minor</i>	L	S4B	Yellow		T	1-T	G5
<b>Amphibians</b>								
Western toad	<i>Anaxyrus boreas</i>	C	S3S4	Blue		SC	1-SC	G4

<sup>1</sup> Confirmed ( C ) = Species that have been confirmed as present within the RSA during baseline studies or by incidental observation; Likely ( L ) = Species that have overlapping seasonal ranges within the study areas, are known to occur within the BEC zones associated with the study areas, and their seasonal habitat requirements are met within the study areas; and Possible ( P ) = Species that may or may not have overlapping seasonal ranges within the study areas, seasonal habitat requirements may or may not be met within the study areas, but species have been detected in BEC zones associated with the study areas. Many migratory bird species can be placed in this category because they are expected to pass over or near the study areas during spring and fall migrations, so their presence would be possible but infrequent (Stevens 1995; Sibley 2000; Stebbins 2003; Alderfer 2006; Reid 2006; CARCNET 2009; BC CDC 2010a; NatureServe 2010).

<sup>2</sup> Wildlife Species that have been identified by an Identified Wildlife Management Strategy (IWMS) through the Ministry of Environment in partnership with the Ministry of Forests and Range (BC MWLAP 2004e). The IWMS provides direction, policy, procedures and guidelines for managing Identified Wildlife to minimize the effects of forest and range practices on Identified Wildlife situated on Crown land and to maintain their limiting habitats throughout their current ranges and, where appropriate, their historic ranges.

**Table 18.3-2. Wildlife Species or Groups of Regional Interest within the Wildlife RSA**

Species Name (scientific name)	Reason of Interest
Moose ( <i>Alces americanus</i> )	Identified as culturally significant and hunted by First Nations <sup>1</sup> . Economically important species to resident hunters and guide outfitters. Candidate provincial ungulate winter ranges (UWR) for moose have been identified in the RSA. Identified as an important species requiring increased management consideration by the Nass South SRMP (BC MFLNRO 2012) and CIS LRMP (BC ILMB 2000).
Mountain goat ( <i>Oreamnos americanus</i> )	Identified as a culturally significant and hunted species by First Nations <sup>1</sup> . UWR for goat identified within the RSA. Identified as an important species requiring increased management consideration by the Nass South SRMP (BC MFLNRO 2012) and CIS LRMP (BC ILMB 2000).
Stone's sheep ( <i>Ovis dalli stonoi</i> )	The CIS LRMP provides direction to maintain large areas of high-value Stone's sheep habitat and avoid disturbing animals during lambing (BC ILMB 2000).
Northern caribou ( <i>Rangifer tarandus</i> pop. 15)	The CIS LRMP provides direction to maintain large areas of important habitat characteristics such as forests with lichen, areas of contiguous mature and old forest, and wetland complexes and managing access and harvesting activities to minimize impact to winter habitat (BC ILMB 2000).
Grizzly bear ( <i>Ursus arctos horribilis</i> )	A species at risk and a species of provincially high profile with continued emphasis on its conservation. It has received prominent consideration in the applicable LRMP and SRMP for the RSA and will continue to be emphasized as a species warranting enhanced consideration to integrate its conservation with development.
American marten ( <i>Martes americana</i> )	Identified as a culturally significant species and trapped by First Nations <sup>1</sup> . Economically important furbearer to local trappers. Identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012) and CIS LRMP (BC ILMB 2000). Identified as a species of interest by the Skii km Lax Ha.
Fisher ( <i>Martes pennanti</i> )	A valuable furbearer species that requires additional management consideration because it is provincially blue-listed and identified in the CIS LRMP for prioritizing habitat conservation (BC ILMB 2000).
Wolverine ( <i>Gulo gulo</i> )	Identified as a species at risk with little knowledge of its behavior or habitat use in the Skeena Region. Increasing emphasis from regulators to include inventory of this species to attain a better understanding locally for assessment of future developments.
Silver-haired bat ( <i>Lasionyceteris noctivagans</i> )	Identified by BC MOE/BC MFLNRO as regionally important in the Skeena Region because of concerns with maintaining maternal roosts in tree cavities.
Raptors	Nests and certain raptor species are protected under the BC <i>Wildlife Act</i> (1996c). The group includes culturally significant raptors identified by First Nations. Identified as important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012) and the CIS LRMP (BC ILMB 2000).
Northern goshawk ( <i>Accipiter gentilis</i> )	Component of biodiversity, reduced conservation concern down listed to yellow, identified in the Nass South SRMP (BC ILMB 2009; BC MFLNRO 2012) as requiring additional consideration. Identified as culturally significant species by local First Nation Bands.
Short-eared owl ( <i>Bubo scandiacus</i> )	The CIS LRMP provides direction to maintain nesting and foraging habitat for nest sites of short-eared owl (BC ILMB 2000).
Waterbirds	Individuals, eggs, and active nests protected under <i>Migratory Birds Convention Act</i> (1994) and BC <i>Wildlife Act</i> (Pahlke, McPherson, and Marshall 1996).

(continued)

Table 18.3-2. Wildlife Species or Groups of Regional Interest within the Wildlife RSA (completed)

Species Name (scientific name)	Reason of Interest
Harlequin duck ( <i>Histrionicus histrionicus</i> )	Harlequin duck are of particular interest to federal regulators as they occupy a unique habitat niche and Pacific populations have undergone declines (Robertson and Goudie 1999). The BC MOE has identified this species as requiring additional conservation and monitoring activities under the BC Conservation Framework to prevent the species from becoming at risk in the future (BC MOE 2009a).
Trumpeter swan ( <i>Cygnus buccinator</i> )	The CIS LRMP identified trumpeter swan wintering habitat as important areas to maintain and recommended that nesting and staging inventories of trumpeter swan be prioritized for research (BC ILMB 2000).
Songbirds	Component of biodiversity, individuals, eggs, and active nests protected under the <i>Migratory Birds Convention Act</i> (1994) and <i>BC Wildlife Act</i> (Pahlke, McPherson, and Marshall 1996).

<sup>1</sup> First Nations refers to the *Ski km Lax Ha*, *Nisga'a Nation*, and *Tahltan Nation*.

The Sulphurets Project was an advanced underground exploration project of Newhawk Gold Mines Ltd. located at the currently proposed Brucejack Mine Site. Underground workings were excavated between 1986 and 1990 as part of an advanced exploration and bulk sampling program. Reclamation efforts following Newhawk Gold Mine Ltd.'s advanced exploration work included deposition of waste rock and ore within Brucejack Lake. The exploration phase of the proposed Brucejack Gold Mine Project commenced in 2011 and has included a drilling program, bulk sample program, construction of an exploration access road from Highway 37 to the west end of Bowser Lake, and rehabilitation of an existing access road from the west end of Bowser Lake to the Brucejack Mine Site.

The Granduc Mine was a copper mine located approximately 25 km south of the Project, and operated from 1970 to 1978 and 1980 to 1984. The mine included underground workings, a mill site near Summit Lake, with an 18.4-km tunnel connecting them. In addition, a 35-km all-weather access road was built from the communities of Stewart, BC and Hyder, Alaska to the former mill site near Summit Lake. The area of the former mill site near Summit Lake is currently used as staging for several mineral exploration projects in the region. The terminus of the Granduc Access Road is 25 km south of the proposed Brucejack Mine Site and is currently used by mineral exploration traffic and tourists accessing the Salmon Glacier viewpoint.

North of the Project is the Eskay Creek Mine, an underground gold and silver mine that operated from 1995 to 2008 and is currently in the decommissioning phase. It has a rather small surface disturbance, with the total area of ecosystems disturbed by the mine and the Eskay Creek Spur Road estimated at less than 50 ha (Murphy and Napier 1996; Barrick Gold Inc. 2004).

In 2010, construction began on the Long Lake Hydroelectric Project which is located approximately 42 km south of the Project. It includes redevelopment of a 20-m-high rockfill dam located at the head of Long Lake, and a new 10-km-long 138-kilovolt transmission line. Construction was completed in late 2013 and the project is currently operating.

#### 18.3.2.2 Forestry

Forest harvesting within the RSA is within the Nass TSA and is minimal compared to many other areas in BC, due to the remoteness of the area and the relatively poor productivity of the forests. Historical harvesting activities were concentrated along the Bell-Irving River and Highway 37 and on the slopes south of Wildfire Creek. Harvesting that has historically occurred within the RSA was extensive in the south and east of the RSA, with little intact forest remaining between Meziadin Junction and Bell 2

Lodge. Forestry roads have been developed within the RSA along Wildlife Creek and Bowser River but currently access is limited due to deactivation of a bridge.

#### 18.3.2.3 Recreational Activities

Recreation activities that occur within the RSA include backcountry helicopter skiing, snowmobiling, river boating/fishing, localized recreational vehicle travel, and backcountry hiking and skiing. Backcountry helicopter skiing occurs throughout the RSA, largely in areas near Bell 2 Lodge in the northern portion of the RSA, and near Stewart within the southern portions of the RSA and LSA. Recreational snowmobilers and skiers also use the Granduc Access Road to access the Long Lake area in the south of the RSA throughout the winter. Winter activities (particularly heli-skiing), are often near goat winter range. River boating to facilitate hunting and salmon fishing occurs along the major rivers in the RSA such as Bell-Irving River, Bowser River, and occasionally along the Unuk River. In the most southern area of the RSA, tourists regularly travel up the Granduc Access Road during the summer and fall for sightseeing activities associated with the Salmon Glacier and grizzly bears feeding on salmon.

#### 18.3.2.4 Fur Harvest

Wild fur harvest from eight traplines (TR 0614 T101, TR 0616 T010, TR 0616 T011, TR 0616 T012, TR 0616 T013, TR 0617 T015, TR 0621 T001, and TR 0621 T003) occurs during the winter in the RSA. Three of the traplines overlap with the Project. Trapline TR 0621 T003 overlaps the proposed Brucejack Mine Site, trapline TR 0616 T012 overlaps the exploration access road and the Brucejack Transmission Line, and TR 0616 T011 overlaps the eastern portion of the exploration access road. A total of 13 furbearer species were reported to be harvested between 1985 and 2009: beaver (*Castor canadensis*), black bear (*Ursus americanus*), marten (*Martes americana*), coyote (*Canis latrans*), ermine (*Mustela ermine*), fisher (*Martes pennant*), mink (*Neovision vison*), muskrat (*Ondatra zibethicus*), red fox (*Vulpes vulpes*), red squirrel (*Tamiasciurus hudsonicus*), river otter (*Lontra Canadensis*), skunk (*Mephitis mephitis*), and wolverine (*Gulo gulo*), according to the provincial Fur Harvest Database. Harvest was predominantly marten. Recent increased demand for wild fur has resulted in increased activity on traplines in BC.

#### 18.3.2.5 Wildlife Hunting

The province is divided into 225 WMUs. Most of the eastern portion of the RSA is within WMU 6-16 (including the access road), with slightly less than a third of the western portion of the RSA within WMU 6-21 (including the Brucejack Mine Site). In addition, a very small area along the northeastern edge of the RSA crosses into Upper Skeena WMU 6-17 between the Bell-Irving River and Highway 37. The Fish, Wildlife and Habitat Management Branch of the BC MFLNRO collects and aggregates harvest data for each WMU. Non-resident harvest in the RSA is primarily concentrated on moose in WMU 6-21 and black bear and grizzly bear in WMU 6-16 and 6-17, and resident harvest in the region focuses primarily on moose, followed by black bear.

Hunting, which has historically occurred and is currently occurring in the area associated with the Project, can affect population sizes, age ratios, sex ratios, sizes, and behaviours of harvested populations. Hunting activities may have historically and currently affected existing wildlife populations within the LSA and RSA. Wildlife species currently harvested in the RSA include moose, black bear, mountain goat, grizzly bear, grouse, and waterfowl. Local hunting activities focus on moose. Harvest rates by recreational hunters, including both guided and resident hunters, are regulated by a permitting and licensing system that is administered by the provincial government.

The RSA is accessible from Highway 37, and along forestry roads that extend from the highway into the areas surrounding Bowser Lake and lower reaches of Treaty Creek. Moose are actively hunted within the interior survey area of the RSA, which likely explains the reduced male to female sex ratio of

55 bulls per 100 cows observed during surveys along the Bell-Irving River and in the Bowser Lake area (Appendix 18-A, 2013 Wildlife Characterization Baseline Report). Access to mountain goat habitat is possible along the Brucejack Access Road at Mount Anderson and along the Granduc Access Road, which runs through goat habitat. However, the Brucejack Access Road is controlled by a manned gate, and will remain so during Construction and Operations, which will limit access to hunters.

#### 18.3.2.6 Aboriginal Harvest

##### Skii km Lax Ha

Skii km Lax Ha asserted territorial boundary extends from the north side of Cranberry River to Ningunsaw Pass, along the Nass and Bell-Irving rivers (Chapter 26, Assessment of Asserted or Established Aboriginal Rights and Interests). Within this boundary, Skii km Lax Ha engage in hunting and trapping (Chapter 25, Assessment of Potential Effects to Current Use of Lands and Resources for Traditional Purposes).

The Skii km Lax Ha currently perform much of their hunting in the wildlife RSA along a circular route that starts at Bowser Lake and ends at Awijii (at Skowill Creek) proceeding along the north side of Mount Anderson and then down the Scott Creek/Treaty Creek valleys, back to the Bell-Irving River. Within this area they are harvesting moose, grizzly bear and mountain goat. In addition, the Skii km Lax Ha actively trapped along Highway 37 starting at the Cranberry River, proceeding north up against Hanna Ridge, to the Skii km Lax Ha cabin on Skowill Creek. This area was trapped for beaver, marten and wolverine. The Skii km Lax Ha advised that they have not recently trapped in the area due to their involvement in a number of power and mineral exploration projects in their territory (Chapter 25; Section 25.3.4.2).

##### Tahltan Nation

Tahltan Nation asserted traditional territory includes the areas surrounding the Stikine River drainage basin in the Coast and Cassiar mountains. The southern boundary of the territory follows the Unuk River drainage from the Alaska/Canada border and along Treaty Creek, where it overlaps the LSA. The closest Tahltan community to the Project is the Iskut First Nation located in the village of Iskut north of the Bob Quinn area along Highway 37 (Chapter 26, Assessment of Asserted or Established Aboriginal Rights and Interests).

To date, the Tahltan have provided limited information on the use of wildlife resources in the wildlife RSA. However, the Teigen-Snowbank-Ningunsaw corridor has been identified in other studies as important to the Tahltan for its wildlife values (Rescan 2009b). The Tahltan have also expressed concern for effects of the Project, especially roads on moose corridors. Trapping for fur-bearing mammals continues to provide a nominal source of income for individuals and families who hold traplines.

##### Nisga'a Nation

The Project falls within the Nass Area, which surround Nisga'a Lands as defined in the *Nisga'a Final Agreement* (2000). Nisga'a people continue to carry out traditional activities such as fishing, hunting, and trapping within these areas (Chapter 25, Assessment of Potential Effects to Current Use of Lands and Resources for Traditional Purposes).

To date, information on hunting activities in the wildlife RSA has not been provided by the Nisga'a Nation. Baseline information has not identified any Nisga'a hunting activity within the parts of the Nass Area that overlaps Project components (Chapter 25; Section 25.3.4.2). Nisga'a people have traditionally

trapped fur-bearing mammals, including marmot, fisher, marten, mink, and weasel, although the level of trapping activity may be in decline (Rescan 2012).

**18.3.3 Baseline Studies**

*18.3.3.1 Objectives*

Baseline studies were conducted to characterize wildlife presence and distribution within the LSA and RSA, and to inventory habitat for the VCs concerned. This included an examination of current wildlife land use management objectives and existing wildlife inventories, identification of species of conservation concern, field inventories, habitat suitability modelling, and DNA programs. Specific study objectives were applied to each wildlife group, as summarized in Table 18.3-3.

**Table 18.3-3. Baseline Study Objectives for Brucejack Gold Mine Project Wildlife Valued Components**

Wildlife Group	Species	Baseline Objectives
<b>Mammals</b>		
Ungulates	Moose	<ul style="list-style-type: none"> <li>Assess the late winter abundance and distribution of moose within the RSA.</li> <li>Identify suitable moose habitat in the RSA by conducting habitat suitability modelling for early winter and late winter habitat.</li> </ul>
	Mountain Goat	<ul style="list-style-type: none"> <li>Collect baseline information on mountain goat seasonal distributions within the RSA and establish baseline estimates for their summer and winter population sizes, herd composition, and distribution.</li> <li>Identify suitable mountain goat habitat in the RSA by conducting habitat suitability modeling for winter and summer habitat.</li> </ul>
Bears	Grizzly Bear	<ul style="list-style-type: none"> <li>Determine the relative abundance and distribution of grizzly bears in the RSA using DNA.</li> <li>Identify suitable grizzly bear habitat in the RSA by conducting habitat suitability modelling for spring, summer, fall, and denning habitat.</li> </ul>
	Black Bear	<ul style="list-style-type: none"> <li>Identify suitable black bear habitat in the RSA by conducting habitat suitability modelling for denning habitat.</li> </ul>
Furbearers	Furbearers (general)	<ul style="list-style-type: none"> <li>Assess the presence of furbearer species in the LSA and RSA, with a particular emphasis on determining whether fisher occur in the area.</li> <li>Determine harvest levels of furbearers from the Fur Harvest Database as a general index for monitoring the ecological integrity of the RSA for furbearers and fur harvest activity.</li> </ul>
	Wolverine	<ul style="list-style-type: none"> <li>Estimate the local population of wolverine in the RSA using DNA.</li> </ul>
	Fisher	<ul style="list-style-type: none"> <li>Identify suitable fisher habitat in the RSA by conducting habitat suitability modelling for denning habitat.</li> </ul>
	American Marten	<ul style="list-style-type: none"> <li>Identify suitable American marten habitat in the RSA by conducting habitat suitability modelling for winter habitat.</li> </ul>
Rodents	Hoary Marmot	<ul style="list-style-type: none"> <li>Identify the numbers and locations of marmot colonies in representative areas within the LSA and conduct site-specific surveys of a sample of colonies to identify habitat characteristics associated with occupied colonies.</li> <li>Identify suitable hoary marmot habitat in the LSA by conducting habitat suitability modelling for the growing season (spring, summer, and fall).</li> </ul>
Bats	General	<ul style="list-style-type: none"> <li>Determine if, and to what extent, bats (with consideration for species of conservation concern) inhabit the LSA within suitable low elevation habitat, and characterize species or groups present in the area surrounding the proposed Project.</li> </ul>

*(continued)*

**Table 18.3-3. Baseline Study Objectives for Brucejack Gold Mine Project Wildlife VCs (completed)**

Wildlife Group	Species	Baseline Objectives
<b>Avian</b>		
Raptors	General	<ul style="list-style-type: none"> <li>• Characterize raptor species in the LSA and RSA.</li> <li>• Locate nests of cliff and tree nesting raptor species in the LSA and RSA.</li> <li>• Determine northern goshawk abundance and distribution.</li> <li>• Document any raptor species of conservation concern in the RSA.</li> </ul>
Waterbirds	General	<ul style="list-style-type: none"> <li>• Characterize seasonal diversity and distribution throughout the LSA and RSA.</li> <li>• Identify important habitats (e.g., breeding sites, migratory staging lakes) in the LSA and RSA.</li> <li>• Identify species of conservation concern in the LSA and RSA during breeding or staging periods.</li> </ul>
Landbirds	General	<ul style="list-style-type: none"> <li>• Estimate the relative abundance and species richness of landbird species.</li> <li>• Determine habitat associations of landbird communities.</li> <li>• Determine breeding evidence and presence of species of conservation concern, with a focus on the LSA.</li> </ul>
<b>Amphibians</b>		
	Western Toad	<ul style="list-style-type: none"> <li>• Identify western toad breeding areas.</li> <li>• Determine presence of other amphibian species in the LSA.</li> </ul>

#### 18.3.3.2 Methods

A range of methods for the Project were used, including a detailed literature review, baseline field surveys, a DNA inventory, and habitat suitability modelling. These methodologies and results are discussed in more detail below and within [Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report, and [Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report.

#### Data Sources and Literature Review

A review of available data and literature was conducted to identify current best practices for wildlife inventory, existing species information, and past environmental studies that have been conducted in the Project area. This provided existing information for wildlife and wildlife habitat in the RSA, supplementing the wildlife field program. A combination of online scientific journals, online provincial databases, online report catalogues, internet tools (including iMap, SPI, Ecocat etc.), the provincial Fur Harvest Database, and information provided directly by regional wildlife inventory specialists, were reviewed and are summarized in Table 18.3-4.

Potentially occurring species at risk were identified from SARA (2002c) and the BC Conservation Data Centre (BC CDC 2013). The Nass South SRMP (SRMP; BC MFLNRO 2012) and CIS LRMP (BC ILMB 2000), provided existing information and data for the RSA (Table 18.3-5). Habitat mapping has been conducted for moose and mountain goat (UWR), grizzly bear (WHA), northern goshawk (Habitat Suitability Index), and important wildlife habitat (e.g., wetlands) in the Nass South SRMP area (M. W. Demarchi 2000; BC ILMB 2009; BC MFLNRO 2012). More information on relevant SRMP and LRMPs is provided in Section 18.2.2.

**Table 18.3-4. Data Sources Used to Supplement the Brucejack Gold Mine Project Wildlife Baseline Studies**

Data Source	Data
BC MFLNRO Fish and Wildlife Branch (BC MFLNRO 2013) and BC MOE Ecosystem Branch (BC MOE 2013a)	Provides harvest data from provincial WMUs, and manages and provides direction to LRMPs.
iMapBC (GeoBC 2011)	Spatial information tool that identifies presence and locations of wildlife in an area through occurrence reports and telemetry locations; helps identify important wildlife habitat, such as UWRs and WHAs.
Ecological Reports Catalogue (EcoCat) (BC MOE 2010a)	Provides access to a database of published wildlife research reports from across the province.
Wildlife Species Inventory database (BC MOE 2013b)	Maintains a database for submitting information from wildlife inventory studies in BC in the form of reports and datasets. Completed datasets and reports are available to the public using the Species Inventory Web Explorer.
BC Conservation Data Centre database (BC CDC 2013)	Online database that collects and disseminates information on plants, animals, and ecosystems (ecological communities) at risk in BC. This information provides a centralized and scientific source of information on the status, locations, and level of protection of these organisms and ecosystems (BC CDC 2013).
Web of Science (Thomson 2013)	University library catalogue with peer-reviewed literature.
WHAs and UWRs	Important wildlife areas that are identified and incorporated into the Brucejack Habitat Suitability Report as well as insight and field results from KSM Project studies and habitat models (BC MOE 2008; Rescan 2010c, 2010b).

**Table 18.3-5. Summary of Wildlife Inventories within or near the Project Regional Study Area**

Wildlife Inventory	Location	Wildlife Resource	Objectives and Outcomes
Stage I Environmental and Socio-economic Impact Assessment for the Sulphurets Property, Section 7.4.3 (Rescan 1989)	Brucejack Mine Site - previously the Sulphurets property owned by Newhawk Gold Mines Ltd.	mountain goat, moose, furbearers, birds, grizzly bears, and black bears	<ul style="list-style-type: none"> <li>Information was gathered from resource mapping and the provincial government</li> <li>Brief aerial and ground surveys were conducted</li> <li>Ungulate habitat capability and wildlife observations were mapped</li> <li>Section 9.8 of the document described the environmental impact assessment which identified habitat loss and hunting associated with the exploration access road and infrastructure footprint</li> </ul>
KSM Wildlife Characterization Report (Rescan 2010b)	Unuk, Bowser, and Bell-Irving River watersheds.	moose, mountain goat, birds, small mammals, grizzly bear, bats, hoary marmot, and herptiles	<ul style="list-style-type: none"> <li>Inventoried and characterized the wildlife resource within the KSM Project RSA</li> <li>Estimated moose, goat, and grizzly bear populations</li> <li>Identified distribution of hoary marmot</li> <li>Characterized bird and small mammal species composition, and identified presence of bats</li> </ul>

(continued)

**Table 18.3-5. Summary of Wildlife Inventories within or near the Project Regional Study Area (completed)**

Wildlife Inventory	Location	Wildlife Resource	Objectives and Outcomes
KSM Project Wildlife Habitat Suitability Baseline Report (Rescan 2010c)	Unuk, Bowser, and Bell-Irving River watersheds	moose, mountain goat, grizzly bear, American marten, hoary marmot	<ul style="list-style-type: none"> <li>Modelled and inventoried suitable habitat for grizzly bear, moose, mountain goat, American marten, and hoary marmot</li> </ul>
Nass South SRMP (BC MFLNRO 2012)	Nass South SRMP area	moose, mountain goat, grizzly bear, northern goshawk	<ul style="list-style-type: none"> <li>Identified moose winter range as Ungulate Winter Range under the FRPA.</li> <li>Identified mountain goat winter range as Ungulate Winter Range under the FRPA.</li> <li>Identified high value grizzly bear habitat through the Wildlife Habitat Area (WHA) process under the FRPA.</li> <li>Identified high value northern goshawk habitat by Habitat Suitability Modelling</li> </ul>
CIS LRMP (BC ILMB 2000)	CIS LRMP area	moose, mountain goat, grizzly bear, American marten	<ul style="list-style-type: none"> <li>Identified high value moose habitat</li> <li>Identified high value mountain goat habitat and kidding areas</li> <li>Identified high value grizzly bear habitat</li> <li>Identified high value American marten habitat</li> </ul>
Galore Creek Mine (RTEC 2006e, 2006f, 2006g, 2006b, 2006c, 2006d, 2006a, 2007, 2008).	Area near Bob Quinn/ Stikine River	moose, mountain goat, grizzly bear, waterfowl, raptors, forest birds, bats, small mammals, herptiles	<ul style="list-style-type: none"> <li>Identified moose, goat, grizzly bear, and American marten habitat</li> <li>Inventoried moose, goat, and grizzly bear populations</li> <li>Identified bat, small mammal, and herptiles</li> <li>Characterized the bird community</li> </ul>
Northwest Transmission Line Project (Rescan 2009d, 2009c)	Linear area from Terrace to Bob Quinn	moose, mountain goat, grizzly bear, bats, waterfowl, raptors, forest birds, herptiles	<ul style="list-style-type: none"> <li>Identified moose, mountain goat, grizzly bear, black bear, fisher, and American marten seasonal habitats</li> <li>Inventoried mountain goat and moose populations</li> <li>Characterized bird, waterfowl, and herptile population</li> </ul>
Red Chris Porphyry Copper-Gold Project (Roberts and Turney 2004)	Tattoga area	moose, Stone's sheep, mountain goat, grizzly bear	<ul style="list-style-type: none"> <li>Habitat suitability mapping for sheep, goat, moose, and grizzly bear</li> </ul>
Keim (2004)	Taku River drainage	mountain goats	<ul style="list-style-type: none"> <li>Determined mountain goat winter movements, winter habitat selection, and core winter habitat using GPS collared mountain goats in the Taku River drainage</li> </ul>
BC MOE (2008)	Nass TSA and Upper Portion of Ningunsaw and Unuk watersheds	mountain goats	<ul style="list-style-type: none"> <li>Identified Ungulate Winter Range (#U-6-002).</li> </ul>
McElhanney (2007a)	Northern Nass TSA	grizzly bears	<ul style="list-style-type: none"> <li>Conducted grizzly bear habitat suitability to support the designation of grizzly bear WHA</li> </ul>
McElhanney (2007b)	Northern Nass TSA	moose	<ul style="list-style-type: none"> <li>Conducted moose winter habitat suitability to support the designation of moose UWR in the northern Nass TSA</li> </ul>

### Wildlife Inventory

Baseline field surveys were conducted following the inventory standards established by the BC Resources Information Standards Committee (RISC). Field surveys were conducted for moose (RIC 2002), mountain goats (RIC 2002), grizzly bears (RIC 1998b), wolverine (Magoun et al. 2011), hoary marmots (RIC 1998i), bats (RIC 1998a), landbirds (RIC 1998g, 1999b), raptors (RIC 2001), waterbirds (RIC 1998c, 1998f, 1998d, 1999c), and amphibians (RIC 1998e, 1998h). Furbearers were also assessed in the wildlife baseline. However, a literature review was conducted of available trapping data rather than field surveys and this was supplemented with incidental field data. Wildlife baseline studies were conducted within the LSA and RSA from 2010 to 2013. The details of the methodology applied and results obtained are reported in [Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report, and summarized for each wildlife group in Sections 18.3.4 through 18.3.6.

### DNA Inventories

DNA techniques were used according to provincial standards to estimate the number of grizzly bears and wolverine that occupied the RSA in 2011 and 2012 (RIC 1998b). Hair samples were non-invasively collected at designated sample sites across the RSA. Genetic analysis was conducted on hair samples by Wildlife Genetics International. A suite of species- and regional-specific microsatellite markers were prescribed to the samples. The genetic analysis provided information on species, individuals, and sex. These processes have been tested and optimized on multiple bear and wolverine population studies for accurate and efficient identification of individuals (Paetkau and Strobeck 1998; Woods et al. 1999; G. Mowat et al. 2002; G Mowat, C Kyle, and Paetkau. 2003; Paetkau 2003, 2004; Boulanger et al. 2006; Mulders, Boulanger, and Paetkau 2007). Individuals identified in the Project were compared to those identified during other regional inventories.

### Habitat Suitability Models

Habitat suitability models provide a means of identifying the spatial extent and distribution of habitats across the landscape and can be used to assess the potential effects of the proposed Project. Habitat suitability models were developed for moose, mountain goat, grizzly bear, black bear, hoary marmot, American marten, and fisher within the RSA and LSA, in conjunction with ecosystem mapping studies ([Appendix 18-B](#)). Wildlife habitat assessments and suitability models followed BC RISC standards (RIC 1999a, 1999d). The results of the habitat suitability models are reported in [Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report, and summarized in Section 18.3.4. Results from habitat suitability mapping are integrated into the effects assessment (Sections 18.6).

#### *18.3.3.3 Baseline Study Areas*

The wildlife and wildlife habitat baseline studies considered two study areas for wildlife inventories for the Project: an LSA and RSA (Figure 18.3-1). The LSA and RSA defined the area for wildlife baseline studies and were modified in extent for the effects assessment (Section 18.4.2.1).

The baseline RSA covers approximately 374,433 ha, and was delineated to reflect the area anticipated to provide habitat for wildlife that may come in contact with proposed Project infrastructure during the course of a season or wildlife's lifetime. Ecological factors such as height of land and watershed boundaries, which can act as barriers to movement, were considered when selecting the RSA boundary. Species information, such as home range, habitat use, and seasonal movement patterns, were also considered. Sufficient area was included beyond the influence of the Project for future monitoring and the effects assessment. The RSA boundary considered anthropogenic features such as Highway 37 and the BC-Alaska border. The following is a description of the RSA boundary working in a clockwise direction:

- The eastern boundary of the RSA includes the Bell-Irving River, an important fisheries and wildlife habitat, and was set along Highway 37. The eastern boundary begins in the north at Snowbank Creek and extends south along Highway 37 past the confluence of the Bowser River and the Bell-Irving River.
- The southeastern boundary of the RSA was set to include the confluence of the Bowser River and the Bell-Irving River and then continues south along Highway 37 to include the wetland complex associated with that confluence.
- The southern boundary follows west along the height of land from Surveyor Creek to the Bear River Ridge. The southern boundary then turns sharply south and follows the ridge to Highway 37 again, so as to encompass sufficient area associated with the proposed Brucejack Transmission Line.
- The southwest extent of the RSA boundary follows the BC-Alaska border for jurisdictional reasons.
- The western extent was set along the Unuk River from the Alaska border at Border Lake Provincial Park up to the northwestern corner.
- The northern boundary then heads northeast along the Unuk River and Teigen Creek to the Bell-Irving River confluence at Snowbank Creek, which is the northern corner of the eastern boundary.

The LSA for baseline studies covers approximately 31,847 ha, and includes a buffer extending at least to the height of land around the outer limits of the proposed Project infrastructure (e.g., proposed Brucejack Mine Site) and associated linear developments (e.g., exploration access road and the Brucejack Transmission Line). The LSA boundaries for baseline studies were designed to incorporate a large area around proposed infrastructure to account for minor changes in infrastructure design and placement for the Project.

#### 18.3.4 Mammal Characterization

Mammals were characterized because of their social, economic, and ecological importance. Mammal species in the Project area are described in the following sections by five groups: ungulates, bears, furbearers, rodents, and bats. Species were selected as representatives of groups for detailed investigation. More information on each species in the RSA and LSA is available in the wildlife baseline reports ([Appendices 18-A](#), 2013 Wildlife Characterization Baseline Report, and [18-B](#), 2013 Wildlife Habitat Suitability Report).

High-rated habitat, as determined by the habitat suitability models developed for the Project, was included in figures for the mammal species targeted: mountain goat, moose, grizzly bear, black bear, fisher, American marten, and hoary marmot. This high rated habitat is referred to as “high-quality” habitat throughout the Application/EIS. High-quality habitat is defined as habitat rated as High (HSR<sup>1</sup> 1) and Moderately High (HSR 2) habitat for species with a six class rating scheme (moose, mountain goat, and grizzly bear [spring, summer, fall]), and High (HSR 1) for species with a four class rating scheme (American marten, hoary marmot, black bear, grizzly bear [denning], and fisher; [Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report). Moderate-rated habitat was not included in the effects assessment but will be considered for monitoring and management of wildlife habitat; because those areas can support wildlife, occurrences may exist ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

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<sup>1</sup> Habitat Suitability Rating

### 18.3.4.1 Ungulates

#### Moose

##### *Background Information*

Moose (*Alces alces*) occur throughout BC's forested areas with an estimated population size of 145,000 to 235,000 animals (BC MFLNRO 2013). Moose are economically and socially important as a species for harvest by Aboriginal and non-Aboriginal hunters. Winter habitat is generally the limiting factor in the carrying capacity for moose in BC because of increased energy demands from moving through snow pack and reduced nutritional quality of forage (Safford 2004a). The southern tip of the RSA overlaps with the Nass Wildlife Area (NWA), which covers an area of approximately 3,677 km<sup>2</sup> immediately south of the RSA (M. W. Demarchi 2011). Approximately 71% of moose in the NWA are migratory, with bulls and cows moving approximately 15 km between seasonal ranges, compared to distances of approximately 6 km moved by non-migratory moose (M. W. Demarchi 2000). Migratory behaviour is learned, and migratory networks are maintained (Bowyer, Ballenberghe, and Kie 2003).

The Nass moose population abundance in the NWA was estimated in 2001, 2007, and 2011. Estimated abundance was 1,595, 638, and 517 animals, respectively (M. W. Demarchi 2011). The moose population in the NWA and Bell-Irving corridor (including part of the eastern extent of the RSA) has declined by 68% in 10 years (M. W. Demarchi 2011).

Baseline aerial surveys for moose were also conducted for the KSM Project in winter 2009 (Rescan 2010b), which covers the same survey units as the Brucejack Gold Mine Project. These surveys indicated that the density and number (adjusted for sightability) of moose was higher in the river valleys of the eastern interior area (0.59 moose/km<sup>2</sup>; 198 moose) than in the western coastal area in the Unuk River valley (0.27 moose/km<sup>2</sup>; 33 moose). In addition, a lower male to female ratio was observed in the interior area (47 bulls for 100 cows), which is consistent with harvest pressure on males where access to high-quality moose habitat is available from Highway 37 along the Bell-Irving River and along some forestry roads near Bowser Lake.

The Nass South SRMP area, which overlaps a small portion of the RSA near Bowser River and Treaty Creek, provides high-value moose habitat, including important calving, rutting, and winter habitat along the Bowser Lake and River drainage systems, Treaty Creek, and the Bell-Irving River (BC MFLNRO 2012). As part of the FRPA (2002c), moose winter range has also been mapped in the eastern half of the RSA to produce proposed UWR polygons, that cover areas along the Bell-Irving River, Bowser Lake, and parts of Treaty Creek (UWR 6-018; McElhanney 2007b).

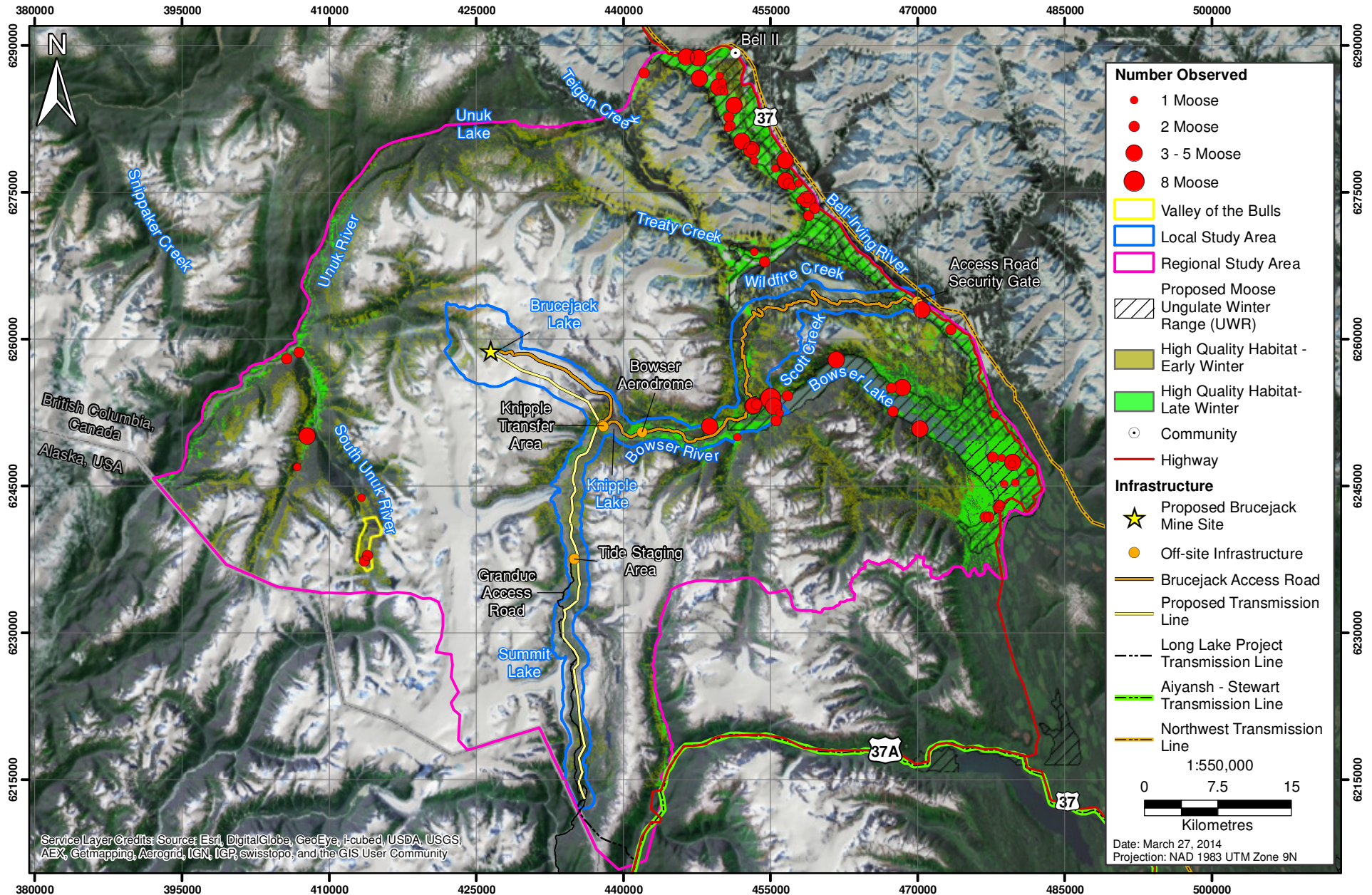
##### *Baseline Studies*

Moose habitat suitability modelling and baseline population inventory focused on winter, because winter habitat is the limiting factor in the carrying capacity for moose in BC (Safford 2004b). Moose winter range within the RSA consisted primarily of low-elevation wetland-timber complexes, river floodplains, large tributary streams adjacent to coniferous stands, and regenerating harvested areas. Baseline aerial surveys were conducted within these types of habitat.

Aerial surveys were conducted for moose during the late winter of 2011 within survey units (SUs) delineated for interior and coastal influenced areas and according to provincial inventory standards (RIC 2002). The density (adjusted for sightability) of moose was higher in eastern interior SUs (0.42 moose per km<sup>2</sup>) near the Bell-Irving River and Bowser Lake, than the western coastal SUs (0.24 moose per km<sup>2</sup>) near the Unuk River valley (Figure 18.3-2).

Figure 18.3-2

Moose Observed during Baseline Surveys and High-quality Winter Habitat



High-quality habitat associated with the interior area included the Bell-Irving River which supported 39 moose (29% of observations), and the Bowser watershed which supported 35 moose (26% of observations; Figure 18.3-2). The coastal area consisted of very little high-quality habitat, resulting in few moose observations. Moose were typically associated with low elevation and riparian habitats, with moderate slopes that support more winter browse and accumulate a lower snow pack relative to the surrounding landscape. The population estimates for moose were lower during 2011 surveys for the Brucejack Gold Mine Project (adjusted population estimate of 174 moose) compared to surveys conducted in the same SUs during late winter for the KSM Project (adjusted population estimate of 231 moose), collected two years previous in 2009 (Rescan 2010b). [Appendix 18-A](#), Wildlife Characterization Baseline Report, provides a summary of moose population estimates from various surveys in northwest BC.

The low elevation and gentle topography of much of the river drainages in the RSA represent moose early and late winter habitat. Figure 18.3-2 summarizes high-quality (HSR 1 and 2) early and late winter habitat in the RSA (see [Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report, for details regarding the habitat suitability models). The early winter model reflects winter browse availability when snow pack is not limiting during periods such as the shoulder periods of winter. Late winter habitat is surveyed and modelled separately because the accumulated snowpack limits the area of moose habitat compared to early winter.

Mapping indicated that High (HSR 1) and Moderately High (HSR 2) early winter habitat for moose covered approximately 15.4% (56,760 ha) of the RSA, and 18.3% (16,918 ha) of the LSA (Figure 18.3-2). The majority of early winter habitat in the LSA occurred along the Bowser River between Bowser Lake and Knipple Lake, and a small patch of HSR 1 early winter habitat was also identified within the Todedada wetland complexes adjacent to the exploration access road. Areas of High and Moderately High early winter habitat within the RSA were modelled along the Bell-Irving River, Treaty Creek, near the confluence of Todedada Creek, and in the northeast corner of the RSA near Snowbank Creek.

High (HSR 1) and Moderately High (HSR 2) late winter habitat for moose accounted for 6.1% (22,337 ha) of late winter habitat within the RSA and 7.6% (2,941 ha) within the LSA (Figure 18.3-2). These areas were primarily located along the Bowser River flood plain, associated with riparian vegetation along the Bell-Irving River, and along Treaty Creek. These areas were also identified as high-quality winter range for moose in the Nass South SRMP (BC MFLNRO 2012) and overlap with the proposed provincial UWR. Moderately High late winter habitat was largely distributed along the Unuk River in the western RSA.

Overall, the Bowser River floodplains between Bowser and Knipple lakes provide the majority of available winter range within the LSA, with interconnected patches of High to Moderately High rated winter habitats throughout. A smaller area of High rated winter habitat in the LSA included the Todedada wetland complexes, which runs adjacent to the exploration access road and can connect patches of High winter habitat along Bowser River to other high-value habitats along Treaty Creek. There was little to no moose habitat identified near the proposed Brucejack Mine Site or the proposed Brucejack Transmission Line route, due to the high elevation of these features.

Moose are known to move along river drainages between seasonal ranges. Areas likely to be used by moose as movement corridors were identified by reviewing topographic connectivity between river valleys. Movement corridors are expected to occur along several of the drainages in the LSA and RSA including: Treaty Creek, Scott Creek, the Unuk River, Bell-Irving River, and the Bowser River drainage system. A relatively small area of High rated winter habitat associated with the Todedada wetland complexes was within the LSA, which can provide connectivity to other areas of winter habitat between the Bowser River floodplain and Treaty Creek. There is a known wildlife trail through riparian areas and wetlands that connects the Treaty Creek watershed to the Bowser River floodplain (McElhanney 2011).

The Ski km Lax Ha hunt along Treaty Creek harvesting moose, grizzly bear and mountain goat. Moose can move considerable distances during seasonal movements and juvenile dispersion; in this assessment it is assumed that the population within the RSA is unbounded and connected to adjacent moose populations.

## Mountain Goats

### *Background Information*

Mountain goats (*Oreamnos americanus*) receive conservation attention from the BC government because they are important for traditional harvest by Aboriginal peoples and recreational harvest for resident and non-resident hunters. Habitat for mountain goats is found throughout the province. However, mountain goats are most numerous in northern BC. The total number of mountain goats in BC was estimated at approximately 39,000 to 66,000 (BC MOE 2010b), of which 16,000 to 35,000 occur within the Skeena Region (BC ILMB 2009).

The BC MOE/BC MFLNRO has identified areas of high-quality mountain goat winter range throughout the province, and has designated these areas as goat UWR. Within the Skeena Region, a designated mountain goat UWR is established within the Nass TSA and the Cranberry TSA (u-6-002; MacLean, Demarchi, and Todd 2006; BC MOE 2008). UWR polygons occur at high elevations along the Brucejack Transmission Line route, along the south facing slopes north of Bowser River and the exploration access road, and on Mount Anderson (between Bowser Lake and the exploration access road).

Land-use management plans and regional studies have also identified important goat habitat within the RSA. The CIS LRMP identifies goat habitat on the Snowslide Range and John Peaks above Sulphurets Creek in the Coulter Creek Access Corridor (BC ILMB 2000; BC MOE 2008). Natal and kidding habitats mapped for the CIS LRMP were also identified on John's Peak and within the RSA west of the Project. Inventory surveys and habitat suitability mapping was conducted for mountain goats by the KSM Project in areas of the RSA during the summer of 2008 and the winter of 2009 and these survey results are included in [Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report.

### *Baseline Studies*

Mountain goat populations were surveyed for the Project in the RSA during the summer of 2010 and 2012, and the winter of 2011 and 2013, following provincial standards for aerial surveys standards (RIC 2002). Surveys were also conducted within some of the same SUs for the proposed KSM Project in summer 2008 and winter 2009; these survey results are included in [Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report, and in the assessment of effects on mountain goats. Winter surveys were conducted to ground-truth winter habitat modelling and estimate distribution of goats in the winter, while summer surveys were used to ground-truth the habitat models and establish the baseline number of goats in the RSA. Sightability during winter is lower when goats occupy forested areas; therefore, summer surveys are used to quantify the goat population.

During the winter surveys (2011 and 2013 combined and in different survey units), 206 (202 in 2011 and 4 in 2013) goats were observed in 86 groups (Figure 18.3-3). During the summer surveys (2010 and 2012 combined), 286 mountain goats were observed in 117 groups (Figure 18.3-4). The majority of goats were observed in mid-elevation habitat along the Bowser River and Bowser Lake near the exploration access road in the winter, and in high-elevation habitat near peaks associated with Sulphurets Creek, west of the Brucejack Mine Site, in the summer. These areas also have provincially-designated UWRs that were occupied by wintering goats in 2012.

Figure 18.3-3

Mountain Goats Observed during Winter Baseline Surveys and High-quality Winter Habitat

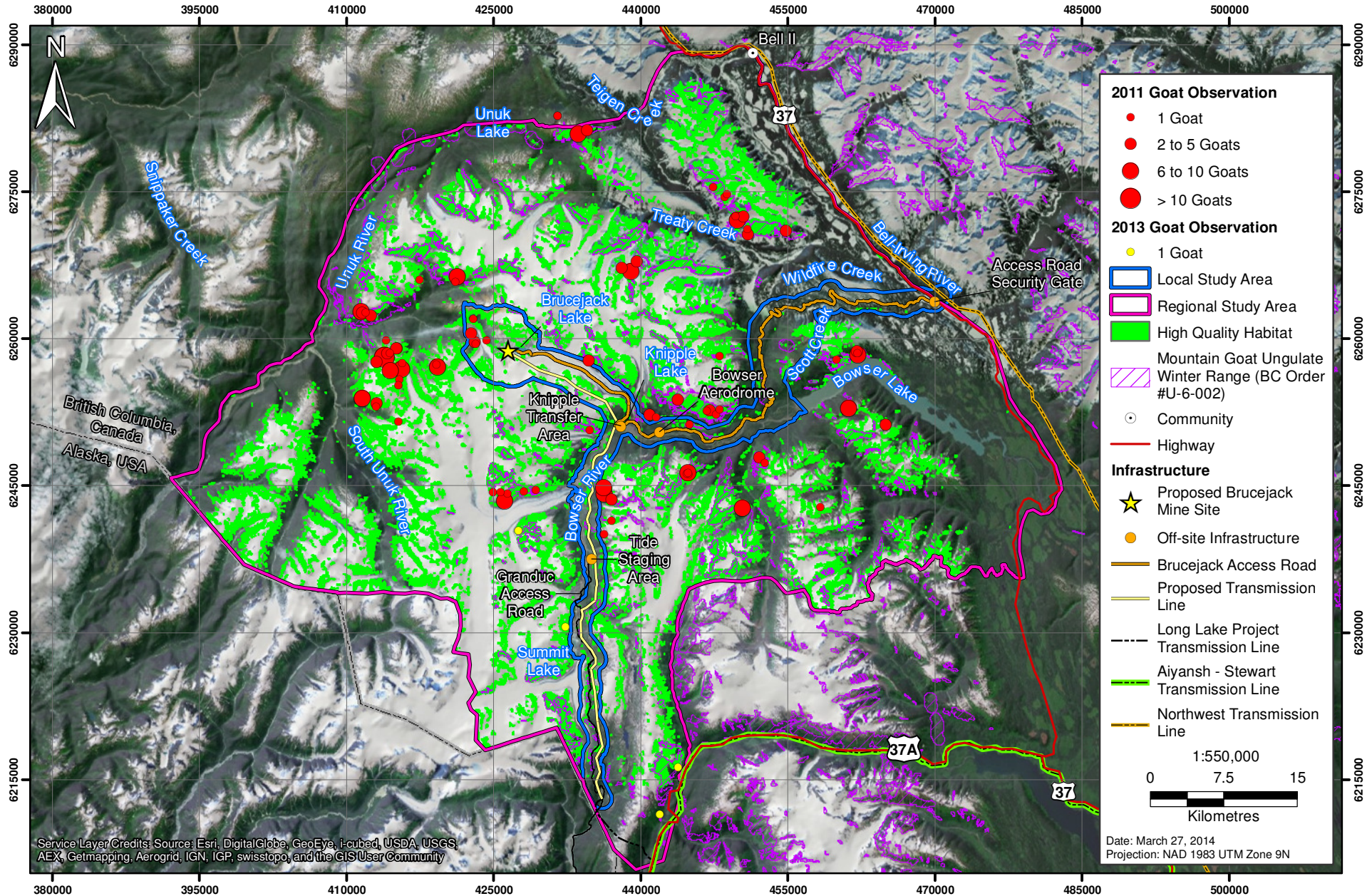
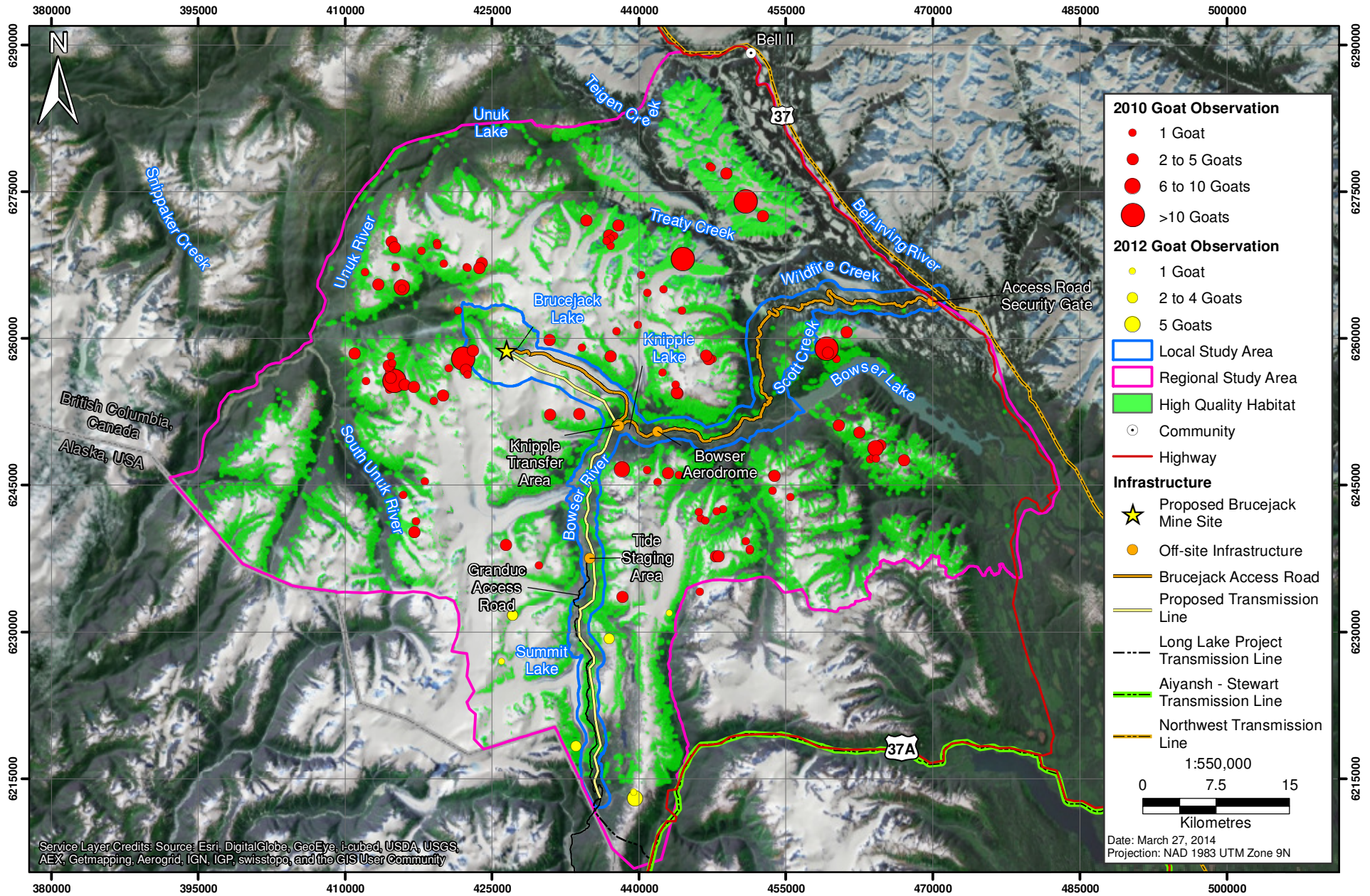


Figure 18.3-4

Mountain Goats Observed during Summer Baseline Surveys and High-quality Summer Habitat



The average mountain goat density in the summer was calculated to be 0.26 goats per km<sup>2</sup> ( $\pm$  0.19 SD) within summer habitat ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). The average mountain goat density in the winter was calculated to be 0.24 goats per km<sup>2</sup> ( $\pm$  0.20 SD) within winter habitat ([Appendix 18-A](#)). Suitable terrain west of the Brucejack Mine Site on either side of Sulphurets Creek supported a substantial proportion of the mountain goat population during the winter and summer (Figures 18.3-3 and 18.3-4). The summer kidding ratio was recorded as 26 kids per 100 adults, which is similar to previous regional estimates (RTEC 2006d, 2008; Rescan 2009d, 2010b; RTEC 2010). The juvenile mortality rate between summer 2010 and winter 2011 was approximately 27%; high kid mortality is common in goat populations and survival can be quite variable from year to year (Festa-Bianchet and Côté 2007).

Mountain goats were observed at a mineral lick within the LSA near the Project above Sulphurets Lake (Figure 18.3-3). A second potential mineral lick was identified in the RSA between Treaty Creek and the Bell-Irving River. Mineral licks receive annual use and are important for the local mountain goat population. They are used primarily during the summer to compensate for mineral deficiencies or imbalances in goats' diet (Ayotte, Parker, and Gillingham 2008).

During baseline studies for goats, incidental observations were recorded for other mountain ungulate species potentially occurring in the RSA, including northern caribou (*Rangifer tarandus*) and Stone's sheep (*Ovis dalli stonei*). One small herd of 10 Stone's sheep was observed incidentally in June 2010, grazing above the tree line between Frank Mackie Glacier and Brucejack Lake. Stone's sheep are yellow-listed in the province because they are widespread and abundant (BC CDC 2013). However, they are protected under the provincial *Wildlife Act* (Pahlke, McPherson, and Marshall 1996), whereby harvesting activities by non-Aboriginals are only permitted under a hunting licence. No other mountain ungulates were observed within the RSA during baseline field surveys or incidentally.

Habitat suitability mapping was conducted for mountain goats to identify winter and summer habitat (Figures 18.3-3 and 18.3-4). A key element of mountain goat habitat is suitable escape terrain (i.e., steep, rocky topography) on warmer south- and west-facing slopes. Due to the abundance of suitable, rocky escape terrain throughout the RSA, high-rated mountain goat habitat for both winter and summer was widely distributed across the RSA. Overall, Moderately High to High-quality winter habitat was mapped across 18% (6,965 ha) of the LSA, and 27% (98,108 ha) of the RSA (Figure 18.3-3; [Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report). Moderately High to High-quality summer habitat was mapped across 23% (8,571ha) of the LSA, and 25% (93,643 ha) of the RSA (Figure 18.3-4).

Most of the high-quality mountain goat habitats within the LSA were identified near the Brucejack Mine Site, within the central LSA north of the exploration access road, and in the eastern LSA along Mount Anderson. Within the RSA, valuable goat habitat areas were identified on Snowslide Range and Longview Range in the eastern RSA, in the mountains south of Treaty Creek, at John Peaks in the western RSA, and patchily distributed for both seasons in the mountains between Sulphurets Creek and South Unuk River. Goat observations collected during baseline studies confirmed that high-quality habitat (i.e., HSR 1 and 2) areas were frequently occupied ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report).

High-quality winter habitat overlapped a large proportion (greater than 80%), of the designated UWR areas. In total, 48% of goats observed during the 2011 and 2013 aerial surveys were within a UWR, represented by 97 goat detections ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). Many occupied areas, however, have not been designated as UWRs.

### 18.3.4.2 Bears

#### Grizzly Bears

##### *Background Information*

Grizzly bears (*Ursus arctos*) are considered a species of special concern by COSEWIC and are blue-listed in BC (COSEWIC 2002b; BC CDC 2010b; COSEWIC 2012b; BC CDC 2013). Grizzly bears were also assessed sub-nationally in 2010 by NatureServe Explorer, and were given an “S3” status, which means they are vulnerable to extinction. Under the provincial BC Conservation Framework priority system, this species was rated on a 6-point scale, with 1 signifying the highest priority for its contribution to achieving three key conservation goals: (1) global efforts for species and ecosystem conservation, (2) preventing species and ecosystem function from becoming at risk, and (3) maintaining the diversity of native species and ecosystems. Grizzly bears were given the ratings 3, 2, and 3 for each of these respective goals, with the highest rating given to their role in helping to achieve conservation goal (2).

Grizzly bear populations are managed for harvest throughout BC and are a significant social and economic element for Aboriginal peoples, resident hunters, and non-resident hunters. Grizzly bears are an Identified Wildlife Element under the Government of BC IWMS, and therefore require special conservation measures within the province (BC MWLAP 2004a, 2004e). They are also considered an umbrella wildlife species. Umbrella species are species that, due to their large home ranges and habitat requirements, may act as a proxy for other species with similar or smaller home range or life requisites if conservation measures are adequate to protect the umbrella species (Roberge and Angelstam 2004).

Grizzly bears are found throughout BC, from sea level and river valleys to alpine regions. BC contains more than 50% of the Canadian population of grizzly bears, with an estimated 13,800 grizzlies in the province (Gyug, Hamilton, and Austin 2004). The distribution of grizzly bears is often related to food supply, with higher densities along streams during salmon runs and on alpine and subalpine slopes when berries are abundant (Hamilton 1987). Grizzly bear management in BC is organized by grizzly bear population units (GBPUs). The RSA intersects three GBPUs: Upper Skeena Nass, Edziza-Lower Stikine, and Stewart GBPUs. The most recent population estimates indicate that approximately 755 grizzly bears occupy the Upper Skeena Nass GBPU, 398 grizzly bears occur in the Edziza-Lower Stikine GBPU, and 358 grizzly bears occupy the Stewart GBPU (Hamilton 2012).

Grizzly bear habitat has previously been modelled in areas that overlap the RSA. High-value habitat was identified by the CIS LRMP within low elevation habitat along the entire Unuk River drainage (BC ILMB 2000). Candidate provincial WHAs have been modelled for the eastern half of the RSA and proposed for Treaty Creek, Bell-Irving River, and Surveyors Creek, which are based on areas identified for the north Nass TSA (McElhanney 2007a). The floodplains of the Bowser River west of Bowser Lake were consistently identified by land-management plans, suitability models, and the province as highly suitable habitat for grizzly bears (McElhanney 2007a; Rescan 2010c). The CIS LRMP recommends strictly avoiding construction of roads within identified grizzly bear critical habitat and, where unavoidable, limiting disturbed areas and scheduling use during less sensitive periods of the year (BC ILMB 2009). The Nass South SRMP suggests minimizing long-term displacement of grizzly bears from industrial access development and preserving the highest value grizzly bear habitat (BC MFLNRO 2012).

##### *Baseline Studies*

The number of grizzly bears in the RSA was estimated during 2011 and 2012 baseline studies using a DNA-based mark-recapture genetic inventory of hairs snagged at sites, according to provincial standards (RIC 1998b). The RSA was used for the DNA inventory grid, and cells within the grid were 7 by

7 km. The grid size was recommended by provincial wildlife staff in the Skeena Region based on the presumed average home range size of a female grizzly bear within this region. Sampling was predominantly conducted at high elevation alpine sites. Hair sampling was also conducted with non-baited trail snags during the fall to assess the use of rivers and creeks by grizzly bears feeding on spawning salmon.

During two years of sampling (2011 and 2012), 37 different grizzly bears were identified within the RSA: 19 females and 18 males. In 2011, 25 individuals were identified (12 males and 13 females), and in 2012, 14 individuals were identified (8 males and 6 females), with only two bears re-captured between both years of DNA inventory. Eleven grizzly bears were detected at two or more sites and the average distance travelled between sampling locations was 22.1 km (SD  $\pm$  20.0 km). Two bears travelled across the RSA from the Unuk River to the Bell-Irving River, a distance of 58.7 km.

Grizzly bears identified in this study were compared with bears from other DNA programs in the region. Seven grizzly bears that were detected during the 2008/2009 KSM Project grizzly bear inventory (Rescan 2010a) and one grizzly bear identified in Alaska (Flynn et al. 2007) were also detected during the Brucejack Gold Mine Project baseline program. In total, 61 different bears have been identified from the Brucejack Gold Mine Project and KSM Project DNA inventories combined. Population estimates were not possible for the Brucejack Gold Mine Project data sets due to low numbers of recaptures; however, the KSM Project super-population (i.e., the total number of grizzly bears that used the RSA during the course of the study) was estimated to be 31 females (range 11 to 50, 95% Confidence Interval) and 27 males (11 to 43, 95% Confidence Interval) for a total of 58 bears (22 to 93) during 2008 and 2009 (Rescan 2010a).

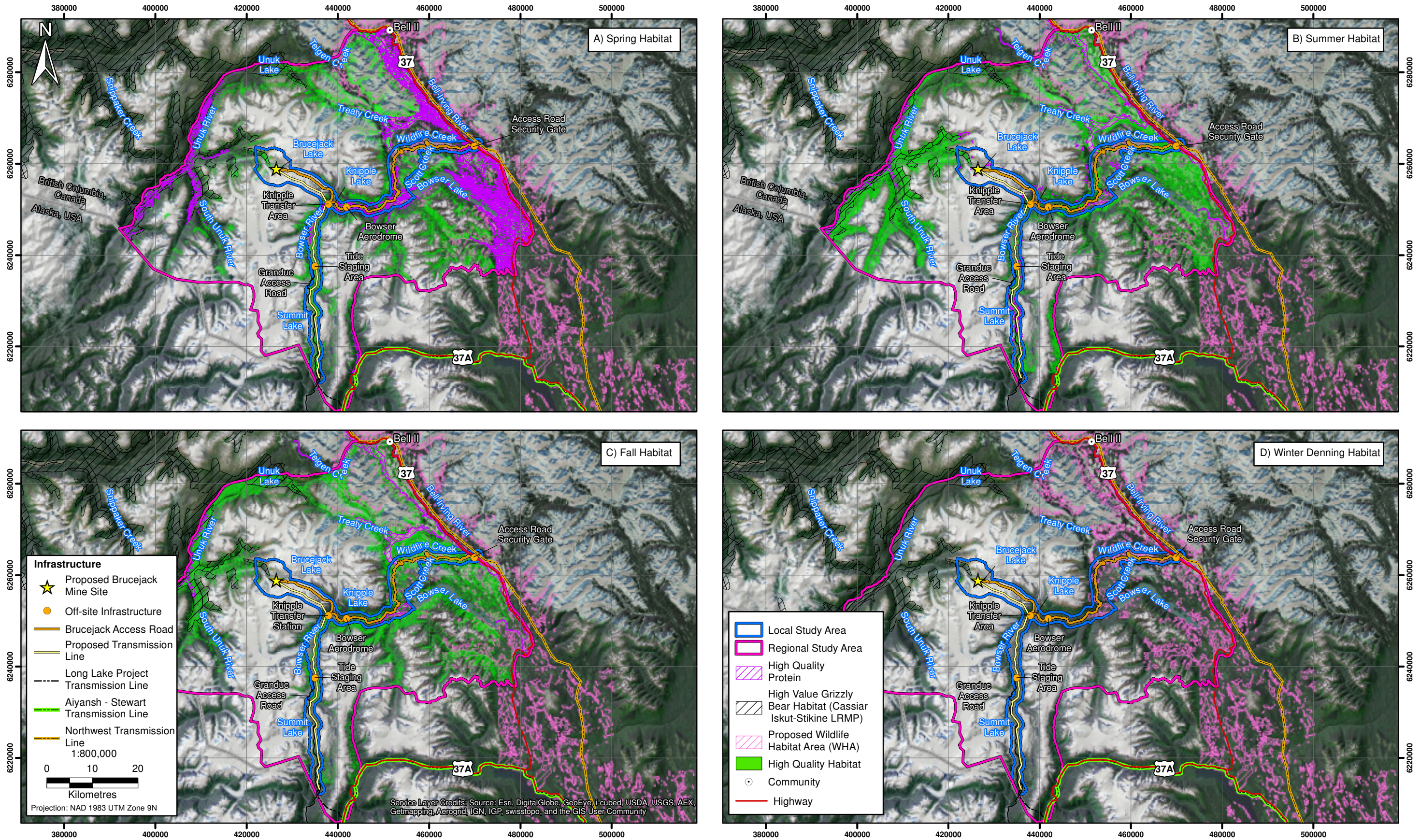
Concentrations of bear detections occurred within the RSA. Between 2008 and 2012, nine different bears were identified feeding on salmon during the fall in a small area along the Unuk River in the northwest corner of the RSA. In summer 2011, 14 individual grizzly bears were detected in high-elevation habitat south of the Bowser River. In late spring 2012, six grizzly bears were identified along riparian habitat of the Bell-Irving River near Bell 2 Lodge, which was also identified as high-quality moose winter range, suggesting the area is likely a source of spring carrion.

Habitat suitability modelling was conducted for grizzly bears in the RSA during the spring, summer, and fall, and in the LSA for winter denning. Habitat was mapped for grizzly bears based on the phenology of vegetation and included the availability of animal protein (moose, salmon, and hoary marmot; Figure 18.3-5). Habitat suitability ratings (HSRs) were ranked relative to the value within the RSA rather than provincial benchmarks.

The diverse terrain within the RSA and LSA provides high-quality grizzly bear spring, summer, and fall habitat. On average for spring, summer, and fall, approximately 18% (15% spring, 21% summer, 18% fall) of the habitat within the RSA and 22% (22% spring, 21% summer, 23% fall) of the habitat within the LSA was rated as Moderately High to High-quality for grizzly bears. Moderate and High-rated winter denning habitat was mapped in 10% of the LSA.

Most of the high-quality seasonal grizzly bear habitat within the LSA occurred north of the exploration access road east of Knipple Glacier, along the Bowser River floodplain, and within the southern portion of the proposed Brucejack Transmission Line route (Figure 18.3-5). An important habitat area was identified along Todedada Creek in low-mid elevations in the spring and summer reflecting the structural diversity associated with the wetlands in that area.

Figure 18.3-5  
High-quality Grizzly Bear Habitat



The addition of moose and salmon animal protein to the model suggested that the Unuk River drainage in the western RSA and the Bell-Irving, Treaty, and Bowser River drainages in the eastern RSA are valuable areas for bears to find winter-weakened moose in the spring and spawning salmon in the summer and fall. The marmot habitat suitability model also suggested that there are considerable areas that may support marmot colonies at mid-elevation above tree line where soils are deep and support vegetation which would enhance summer habitat for bears at those locations. Summer feeding areas based on marmot availability were identified above the Bowser River floodplain and along Mount Anderson. During the fall, suitable habitat occurred along the Bell-Irving River, within the Bowser River floodplains, along the Unuk River, and at Treaty Creek. These fall high-value habitat areas support late persisting berries in the riparian forests (red osier dogwood, high brush cranberry, oval leaved huckleberry), and provide access to spawning salmon.

### Black Bears

Black bears (*Ursus americanus*) are common and widespread in BC. The provincial population estimate in 2001 was between 120,000 and 160,000, with highest densities along the coast, including the RSA (Blood 2001). Black bears were incidentally detected during field studies along all river drainages, particularly along the Unuk, Bell-Irving, and Bowser rivers; Treaty and Teigen creeks; and near Bowser Lake.

Black bears have similar foraging patterns to grizzly bears during the growing season; therefore, some black bear spring, summer, and fall foraging habitat are represented by the grizzly bear models for spring and summer habitat. Grizzly bears, however, often exploit more open alpine habitat while black bears tend to utilize lower elevation forested areas. Black bears exploit different habitat than grizzly bears for denning; therefore, black bear denning habitat was modelled separately ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

Black bear dens are typically in or beneath large diameter trees or wooden structures derived from trees. Cavities in old-growth structures, including large old trees, stumps, root bolls, and logs with a diameter greater than 85 cm are suitable for dens. Moderate and High-quality denning habitat was identified in 3% (11,251 ha) of the RSA and 6% (1,698 ha) of the LSA. This habitat occurred in low elevation riparian areas associated with the larger rivers in the RSA, including the Bell-Irving River, Treaty Creek, Unuk River, and upper and lower Bowser River. Field studies confirmed suitable large diameter black bear denning trees along the Bell-Irving River, Treaty Creek, Bowser River, and the confluence of Snowbank and Teigen Creeks.

#### 18.3.4.3 *Furbearers*

In BC, furbearers are legally designated species that have traditionally been hunted or trapped for their fur and are thus a valuable economic and cultural resource. Initiatives within the CIS LRMP have emphasized provisions for managing furbearer populations as a sustainable resource (BC ILMB 2000). The RSA supports a diverse group of furbearing species. Approximately 35% of the total provincial harvest is generated from the Skeena Region, second only to the 43% from the Omineca-Peace Region (Hatler D.F and Beale 2003). Data for furbearers were collected by three methods: present/not detected using the provincial Fur Harvest Database (desk-based study), socio-economic studies (desk-based study), and incidental data collected during baseline field surveys (field study).

Two furbearing species of conservation concern were identified within the RSA: wolverine (*Gulo gulo*), which is provincially blue-listed and identified by COSEWIC as Special Concern, and fisher (*Martes pennant*), which is also provincially blue-listed (COSEWIC 2003b; BC CDC 2013). Wolverine and fisher are Class 2 furbearers, meaning they are sensitive to harvest and are managed by provincial regulations. The Nass South SRMP recommends management consideration for these two species (BC MFLNRO 2012).

The BC Fur Harvest Database identified 14 species that were harvested in areas within and surrounding the RSA from 1985 to 2009 (R.D. Weir 2012). The most commonly trapped species were American marten (*Martes Americana*), American beaver (*Castor Canadensis*), and red squirrel (*Tamiasciurus hudsonicus*). Marten accounted for the majority of the reported trapper harvest, followed by beaver and squirrel. Trapped species also includes the provincially blue-listed fisher and the federally listed wolverine (Special Concern).

Nine furbearer species were confirmed to be present in the RSA, based on incidental observations collected during baseline studies. The nine species observed included: wolverine, fisher, American marten, red squirrel, grey wolf (*Canis lupus*), black bear, red fox (*Vulpes vulpes*), mink (*Neovision vison*), and beaver. Lynx (*Lynx canadensis*) and ermine (*Mustela ermine*) were not detected during baseline studies and were reported as rarely harvested in the Fur Harvest Database, suggesting low abundance relative to other furbearing species. Muskrat were not detected and the RSA had minimal suitable habitat.

Three species were selected for baseline studies and/or habitat suitability modelling: wolverine, fisher, and American marten. These three species are discussed in more detail below.

## Wolverine

### *Background Information*

The wolverine is a species of conservation concern with provincial (blue-listed) and federal (Special Concern) designations (COSEWIC 2003b; BC CDC 2013). Wolverine have also been assigned a high priority rating of 2 for goal 2 of the Conservation Framework in BC, highlighting the importance that the province has placed on preventing this species and its habitat from becoming at risk. The conservation of the wolverine has received increasing attention in northwestern BC from provincial regulators as they are one of the most valuable furbearers available to trappers in northwest BC, and habitat selection is negatively influenced by human activity, including roads, infrastructure, and backcountry recreation (May R et al. 2006; Krebs, Lofroth, and Parfitt 2007).

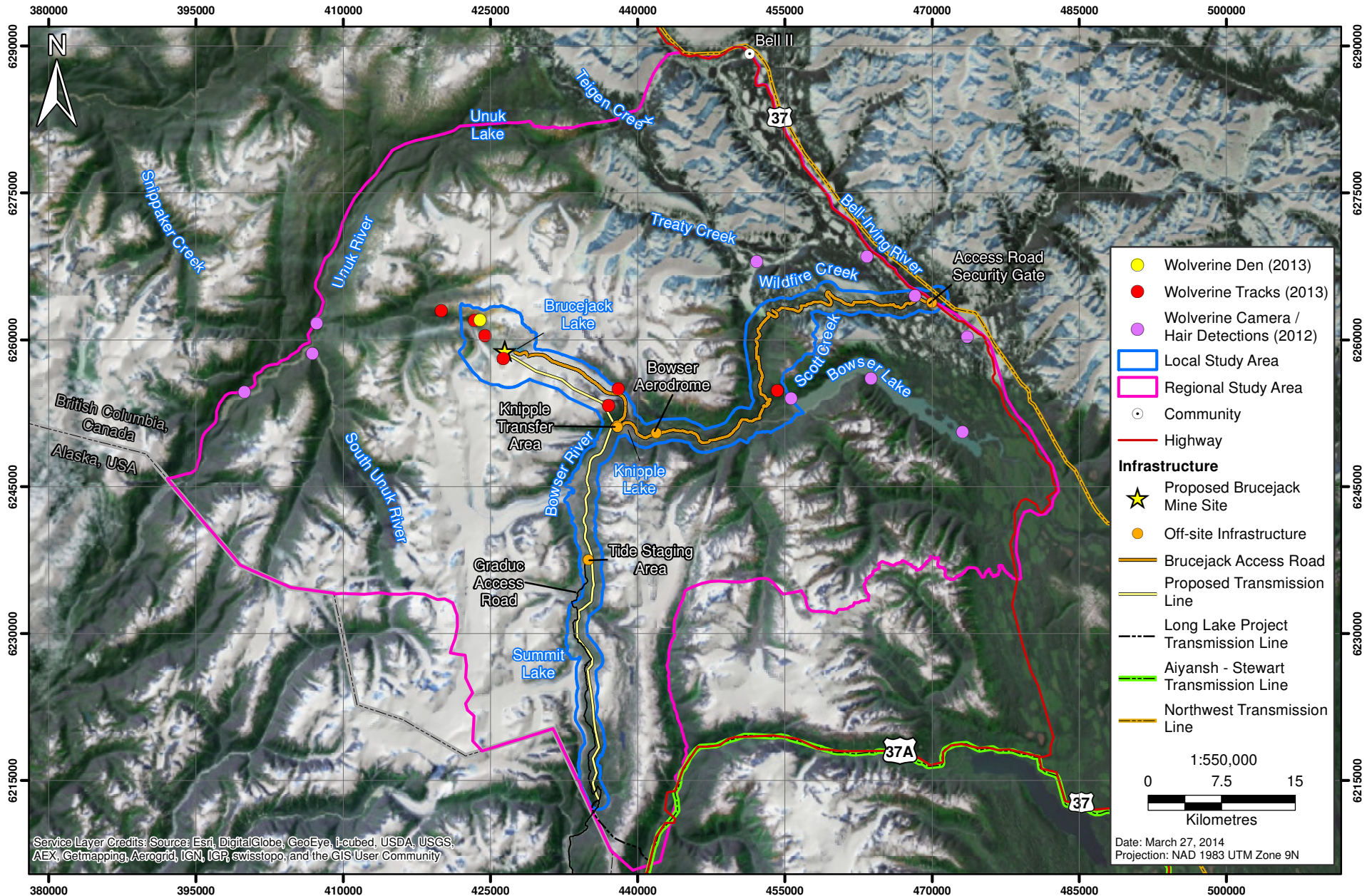
Between 1985 and 2004 the population estimate for the provincial wolverine population unit (PU) 14 (Upper Skeena-Nass), that overlaps the RSA was 134 individuals (95% CI 93-202), with an estimated density of 5.6 wolverine per 1,000 km<sup>2</sup>. This PU is considered a sustainable population based on estimates of net recruitment and current harvest rates (Lofroth and Ott 2007). However, it has been identified by Lofroth and Ott (2007) that additional mortality within this PU of greater than four wolverines per year could affect the stability of the population.

### *Baseline Studies*

In the winter of 2012, wolverine hair sampling stations were set-up in conjunction with remote cameras at 10 sites in late-winter moose habitat. These areas were chosen because they may provide carrion and, as a result, attract wolverines. Genetic analysis and ventral pelage marking comparisons were used to identify individual wolverines. Five different wolverines were identified from DNA analysis (three females and two males), and seven individuals were identified from the remote cameras at nine locations (Figure 18.3-6). In general, wolverines were confirmed along the Unuk River, Bowser Lake, Bell-Irving River, and Treaty Creek watersheds. Recapture rates were low for wolverine at the camera and hair sampling stations; therefore, it is likely that the local population using the RSA is larger than seven individuals (Appendix 18-A, 2013 Wildlife Characterization Baseline Report). The entire RSA area is just over 13% of the spatial extent of wolverine PU 14; however, the area of moose winter habitat, which was the focus of this inventory, is 3% of the PU. The total of seven individuals represents 5% of the estimated 134 wolverines within the PU that overlaps with the RSA.

Figure 18.3-6

Wolverine Observed during Baseline Track Surveys and Den Surveys



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Date: March 27, 2014  
Projection: NAD 1983 UTM Zone 9N

An aerial survey for wolverine dens was conducted in March 2013, which consisted of flying over suitable high-elevation habitat where natal dens are typically located. Effort was directed at areas within the LSA and most closely associated with proposed and existing Project infrastructure and activities. One wolverine den was confirmed less than 5 km northwest of the Brucejack Mine Site and within the LSA (Figure 18.3-6). Distinct sets of tracks were observed at six locations within the LSA, often covering extensive areas over mountains and across lower elevation glaciated areas (Figure 18.3-6). Tracks were observed near proposed Project infrastructure along the winter access snow-cat road, near the perimeter of camp, and near a fuel storage site outside of the camp area.

## Fisher

### *Background Information*

Fisher are a valuable BC furbearer and require management consideration because they are provincially blue-listed (BC CDC 2013). Fisher have also been assigned a high priority rating of 2 for goal 3 of the Conservation Framework, which highlights the importance to conserve this species as part of the overall goal of conserving native species and ecosystems in BC. Habitat degradation has been noted as a key factor in the decline of fisher in BC largely because suitable denning trees and mature forest stands are frequently harvested (BC CDC 2013). Fisher are considered sensitive to forest harvest and they avoid large openings, including roads, due to predator exposure (BC ILMB 2009; Rescan 2013). Protection of riparian habitat, in particular stand structure and connectivity, has been identified within the CIS LRMP as a necessary conservation strategy for fisher (BC ILMB 2000). The wildlife RSA is at the northwestern edge of fisher distribution in BC (R. D. Weir 2003).

### *Baseline Studies*

Fisher were observed during baseline surveys in the winter of 2012 at the confluence of the Bell-Irving River and Treaty Creek (Rescan 2013). A habitat suitability model was developed for the natal denning period for fisher. Fisher require cavities in large trees for giving birth and rearing young during winter and early spring (R. D. Weir and Almuedo 2010). A single model was designed for fisher and black bear denning because of their shared habitat requirements for large trees in low elevation areas ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

Over 75% of the forested habitat within the RSA and LSA was identified as unsuitable denning habitat for fisher. High-quality habitat was found to occupy less than 5% of both the RSA and LSA. High-rated habitat occurred in low elevation riparian areas associated with the Bell-Irving River, Treaty Creek, Unuk River, and the upper and lower Bowser River. The majority of suitable habitat within the LSA was along the flood plains of the Bowser River. The exploration access road occurs in areas modelled as being high-quality habitat in the Bowser River floodplain.

## American Marten

### *Background Information*

The Ski km Lax Ha value American marten due to its importance as a furbearer. American marten accounted for 73% of the reported harvest from registered traplines located in the RSA between 1985 and 2009 (R.D. Weir 2012). American marten was identified in the CIS LRMP as requiring increased management consideration because it is the largest component of the regional fur harvest (BC ILMB 2000). American marten are abundant throughout most of the province and are not a species of conservation concern. However, the American marten was given a high priority rating (2 out of 6) for goal 2 of the provincial Conservation Framework, which highlights the importance that the Province has placed on preventing this species and its habitat from becoming at risk.

### *Baseline Studies*

The presence of American marten in the LSA and RSA was confirmed by remote cameras during baseline surveys. The majority of images recorded by the remote cameras established for the wolverine inventory were of American marten.

Habitat suitability modelling was conducted for winter habitat for American marten. Winter is considered the limiting season for marten, and is the period when they are actively trapped for fur. Marten use mature and old-growth conifer forest as winter habitat, which is common in the low elevations of the LSA and RSA. High-rated winter habitat was extensively distributed throughout low-elevation mature stands of the RSA and LSA along major river valleys including: the Unuk, Bowser, and Bell-Irving rivers, and Treaty, Scott, and Wildfire creeks (Figure 18.3-7). Highly-quality habitat accounted for approximately 20% of the total RSA and 24% of the LSA, reflecting the abundance of late seral stage conifer forest. Most of the forest habitat along the eastern portion of the exploration access road was ranked High but very little high-quality habitat was mapped along the Brucejack Transmission Line route or near the proposed Brucejack Mine Site, where the high elevation and climate conditions restrict forest growth.

#### *18.3.4.4 Hoary Marmot*

##### Hoary Marmot

##### *Background Information*

The hoary marmot has cultural significance to Skii km Lax Ha and importance as a prey species for larger carnivores. Baseline surveys for hoary marmot colonies and habitat suitability modelling were conducted within the LSA in 2012. This species typically occurs in the RSA in alpine areas. First Nations refer to both hoary marmot and ground squirrel as “groundhog.” Within the RSA, only hoary marmots were observed during baseline surveys.

##### *Baseline Studies*

Within the LSA, a total of 173 marmot colonies were located and approximately 67% of the colonies were classified as occupied. The colonies were found to be abundant but not evenly distributed. Survey units north of the exploration access road along Mount Knipple (SU 7), and south of the exploration access road along Mount Anderson (SU 4), contained the majority (N = 60 and N = 62, respectively) of colonies (Figure 18.3-8). The SU that included the area around Brucejack Lake and the deposit (SU 2) supported 29 colonies. The average density of marmot colonies was estimated to be 1.4 ( $\pm$  0.8 SD) per km<sup>2</sup> for habitat between 1,100 and 1,600 m (i.e., capable habitat where marmots occur). These density estimates are similar to density estimates from regional data (Rescan 2010b). Most colonies were found on west to southeast facing aspects with slopes between 20 and 40%. Soils at marmot colonies were typically well-drained and loamy with significant herb and heather-heath vegetation components. Talus or boulders were present at 50% of the colonies for shelter.

Habitat modelling was conducted for the hoary marmot; however, 28% of the LSA (8,924 ha) was not included because it occurred in lower elevation forested habitat along river valleys, which is not used by marmots. Additional areas adjacent to but outside of the LSA boundary totalling approximately 17,509 ha were incorporated into the model because of available ecosystem and soils data. High-quality marmot habitat was distributed across alpine areas in approximately 25% of the LSA. High-quality habitat was identified adjacent to the proposed Brucejack Mine Site and patchily distributed along the exploration access road near the slopes of Mount Knipple and Mount Anderson (Figure 18.3-8). Field verification of the model confirmed that higher rated areas were located at high elevations with deep soils, moderate slopes, and herbaceous vegetation.

**Figure 18.3-7**  
**High-quality American Marten Winter Habitat**

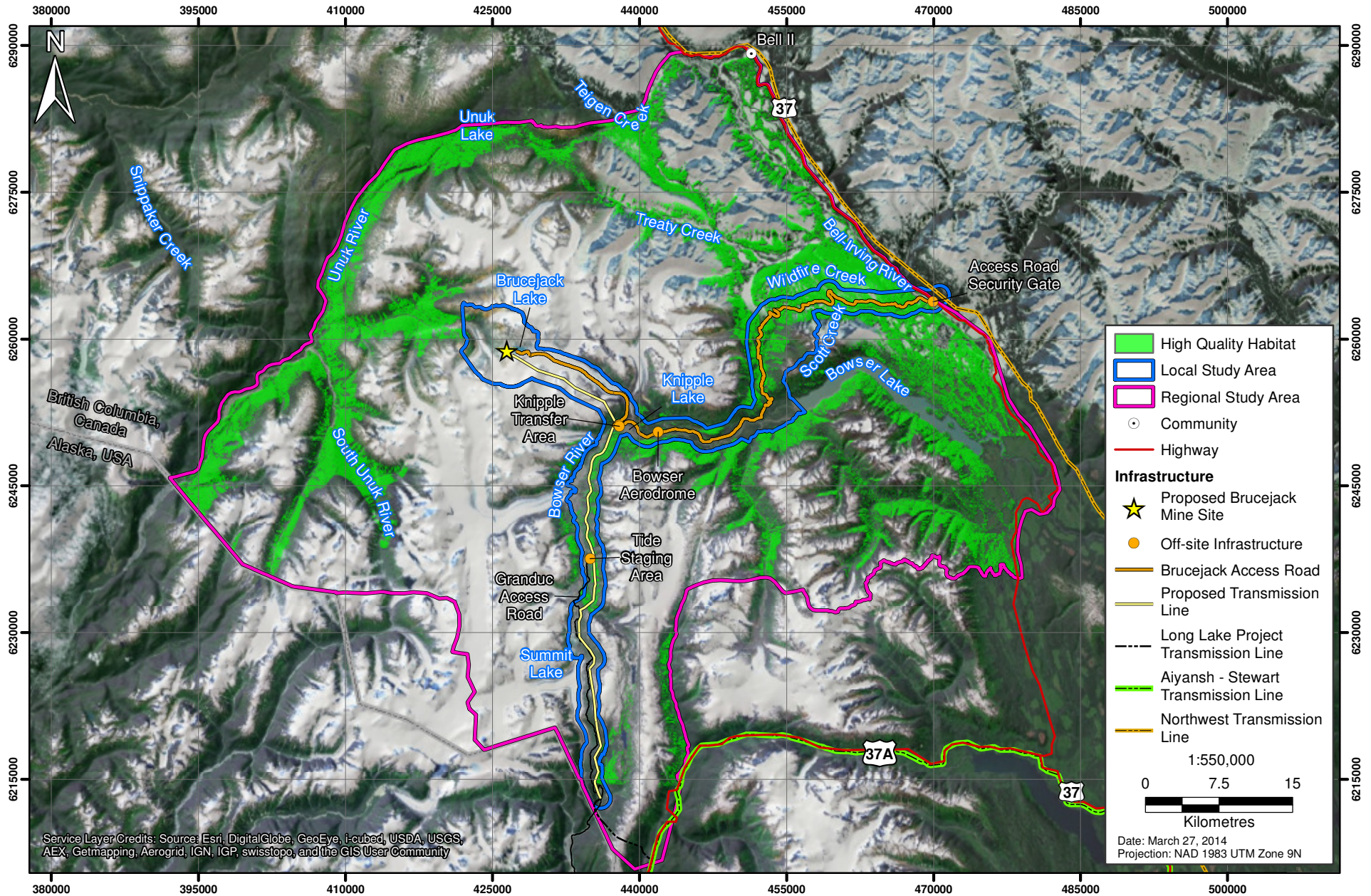
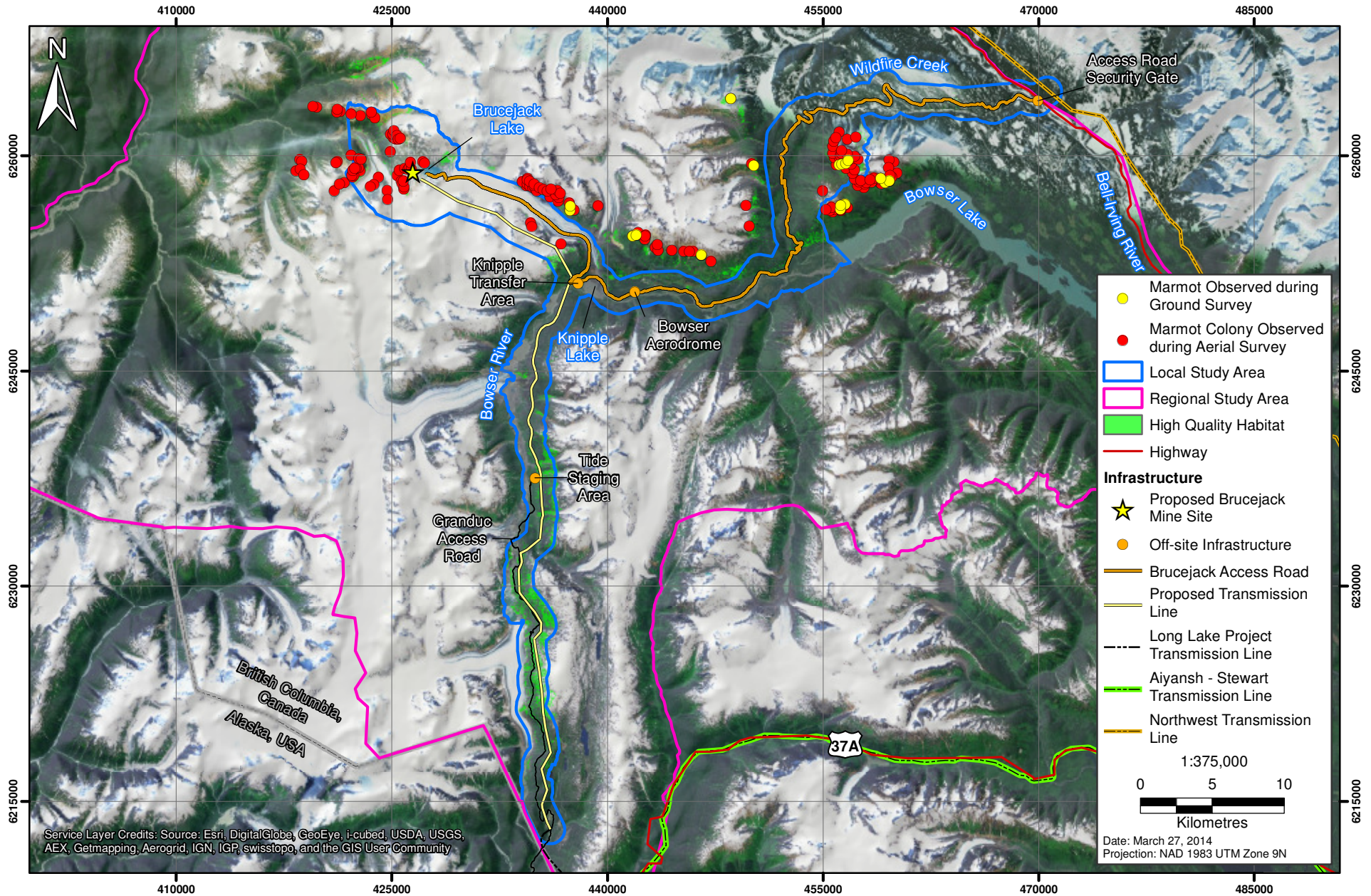


Figure 18.3-8

Hoary Marmot Colonies Observed during Baseline Surveys and High-quality Habitat



#### 18.3.4.5 Bats

##### Background Information

Based on the distribution of bat species in BC, three species of bats that are of provincial and federal conservation concern could occur in the Project area: northern long-eared myotis (*Myotis septentrionalis*), Keen's long-eared myotis (*M. keenii*), and little brown myotis (*M. lucifugus*; Nagorson and Brigham 1993).

The northern long-eared myotis is blue-listed in BC and was given a high-priority rating of 2 for goal 3 (maintaining native species diversity) under BC's Conservation Framework. Keen's long-eared myotis is provincially red-listed (BC CDC 2013) and federally listed as Special Concern under SARA, Schedule 3 (COSEWIC 2003a). Keen's long-eared myotis has also been granted the highest priority level (1 out of 6) under BC's Conservation Framework for goals 1 (global efforts for species conservation) and 3. The little brown myotis has been federally listed by COSEWIC as Endangered (COSEWIC 2012c). In addition, the silver-haired bat (*Lasionycteris noctivagans*) has been identified by BC MFLNRO as important in the Skeena Region because of concerns with maintaining maternal roosts in tree cavities (BCTS 2008; Rescan 2010d), and has been given a priority rating of 2 for goal 2 under BC's Conservation Framework, namely preventing native species from becoming at risk.

Bats use a combination of habitat types during the year, primarily old-growth conifer forests with snags for roosting and riparian areas for foraging (Nagorsen and Brigham 1995; Ormsbee 1996; Sasse and Pekins 1996; Grindal, Morissette, and Brigham 1999; Vonhof and Wilkinson 1999). Determining the presence of these bat species in the proposed development area is required to meet the obligations of provincial regulations under the BC *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) for species protection.

##### Baseline Studies

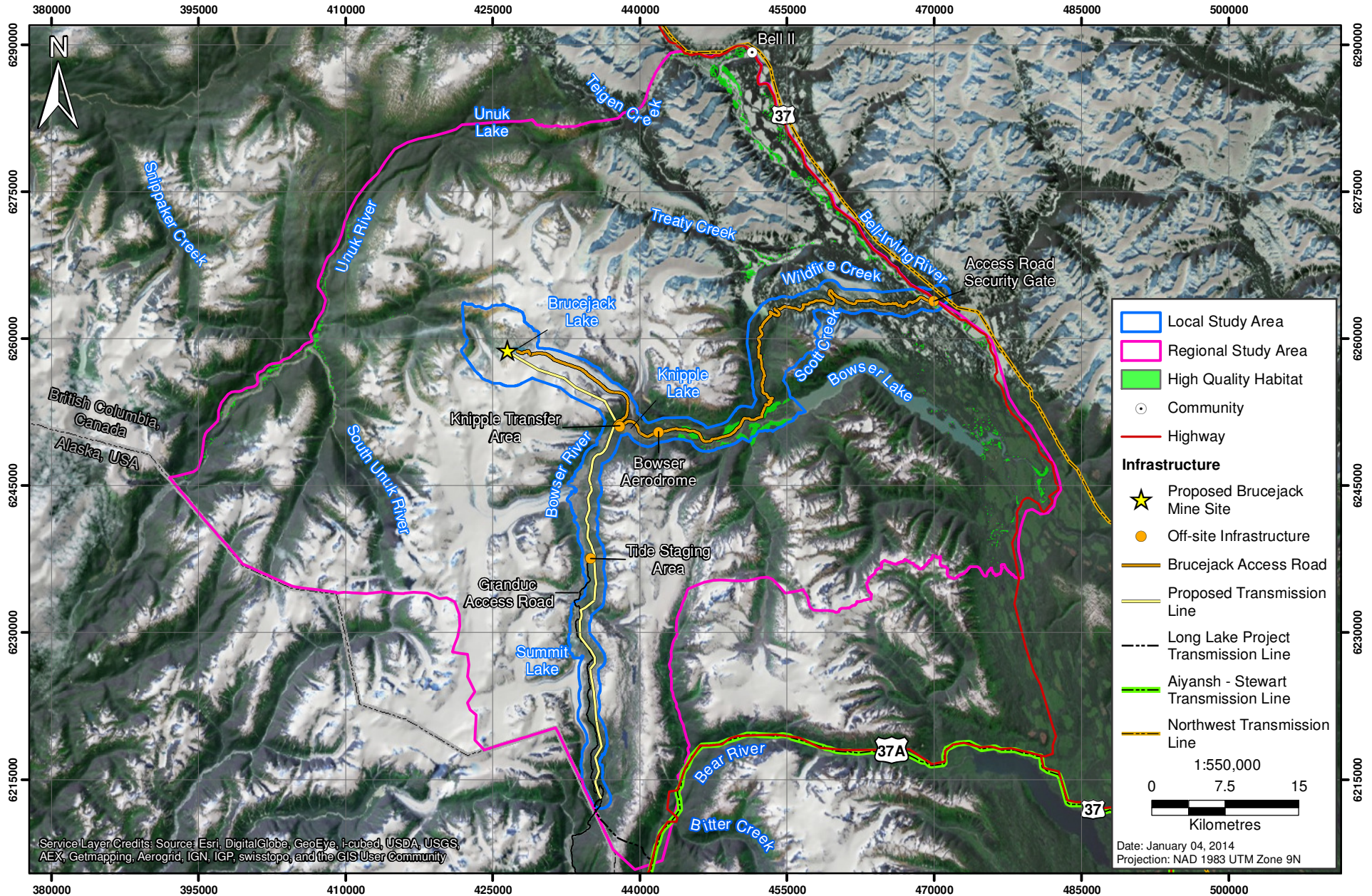
An inventory for bats was conducted in the summer of 2012 at low-elevation sites within the LSA according to provincial standards (RIC 1998a). Bat echolocation calls were recorded at five forest sites. A large proportion of bat detections occurred at a lake between Wildfire Creek and McInnes Creek watershed and in riparian habitat along the Scott Creek and Bowser River confluence. Bat echolocation sonogram analysis suggested that as many as seven species of bats were detected. The western long-eared myotis and the little brown myotis were detected with high confidence. These detections are supported by previous detections made for the KSM Project of western long-eared myotis and little brown myotis within the wildlife RSA in 2009 along Teigan and lower Sulphurets creeks (Rescan 2010b).

Habitat modelling was conducted in the RSA and some areas were identified as high-quality roosting habitat for bats. Cavities in old-growth structures are used as roosting sites for bats. Roosting habitat for bats was modelled similarly to black bear denning habitat and was identified in 3% (11,251 ha) of the RSA and 6% (1,698 ha) of the LSA (Figure 18.3-9). This habitat occurred in low-elevation riparian areas associated with the larger rivers in the RSA, including the Bell-Irving River, Treaty Creek, Unuk River, and upper and lower Bowser River.

#### 18.3.5 Avian Characterization

Avian species that migrate between countries receive protection under the federal *Migratory Bird Convention Act* (1994). Some bird species, including raptors; active bird nests; and some inactive raptor nests, are afforded protection under the provincial *Wildlife Act* (Pahlke, McPherson, and Marshall 1996), while avian species at risk are protected under the federal SARA (2002c).

**Figure 18.3-9**  
**Bat Maternal Roosting Habitat in the Regional Study Area**



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aergrid, IGN, IGP, swisstopo, and the GIS User Community

The bird community within the study areas was characterized according to three avian groups: raptors, waterbirds, and landbirds. During 2010 and 2012 baseline studies, 89 bird species were detected: six raptor species, 28 waterbird species, and 55 landbird species. Raptors include hawks, falcons, owls, and other birds of prey. The term waterbird is used to encompass all birds that exclusively use water as habitat for foraging, breeding, or spring and fall staging during the year and includes diving and dabbling ducks, loons, geese, swans, shorebirds, and riverine birds. Landbirds include songbirds, hummingbirds, woodpeckers, and game birds in terrestrial areas. Baseline study results of each avian group are presented in the following sections.

#### 18.3.5.1 Raptors

##### Background Information

The landscape surrounding the Project is characterized by severe topographical relief that supports cliff-nesting raptors and stands of mature forest at lower elevations that support tree-nesting raptors. Active nests of all raptor species are protected under the BC *Wildlife Act* (1996) and the General Management Direction in the CIS LRMP provides a series of guidelines to maintain raptor nesting and foraging habitat (BC ILMB 2000). Raptors, particularly northern goshawk (*Accipiter gentiles*), are identified as important species in both the CIS LRMP (BC ILMB 2000) and the Nass South SRMP (BC MFLNRO 2012). Suitable northern goshawk breeding habitat has been identified in the LSA on the forested plateau above Wildfire Creek and up to the Treaty Creek plateau within the RSA (McElhanney 2011).

Previous studies conducted for the adjacent KSM Project in 2008 and 2009 identified osprey (*Pandion haliaetus*), merlin (*Falco columbarius*), rough-legged hawk (*Buteo lagopus*), and Swainson's hawk (*Buteo swainsoni*) as present within the RSA (Rescan 2010b). The rough-legged hawk is blue-listed and the Swainson's hawk is red-listed in BC (BC CDC 2013).

##### Baseline Studies

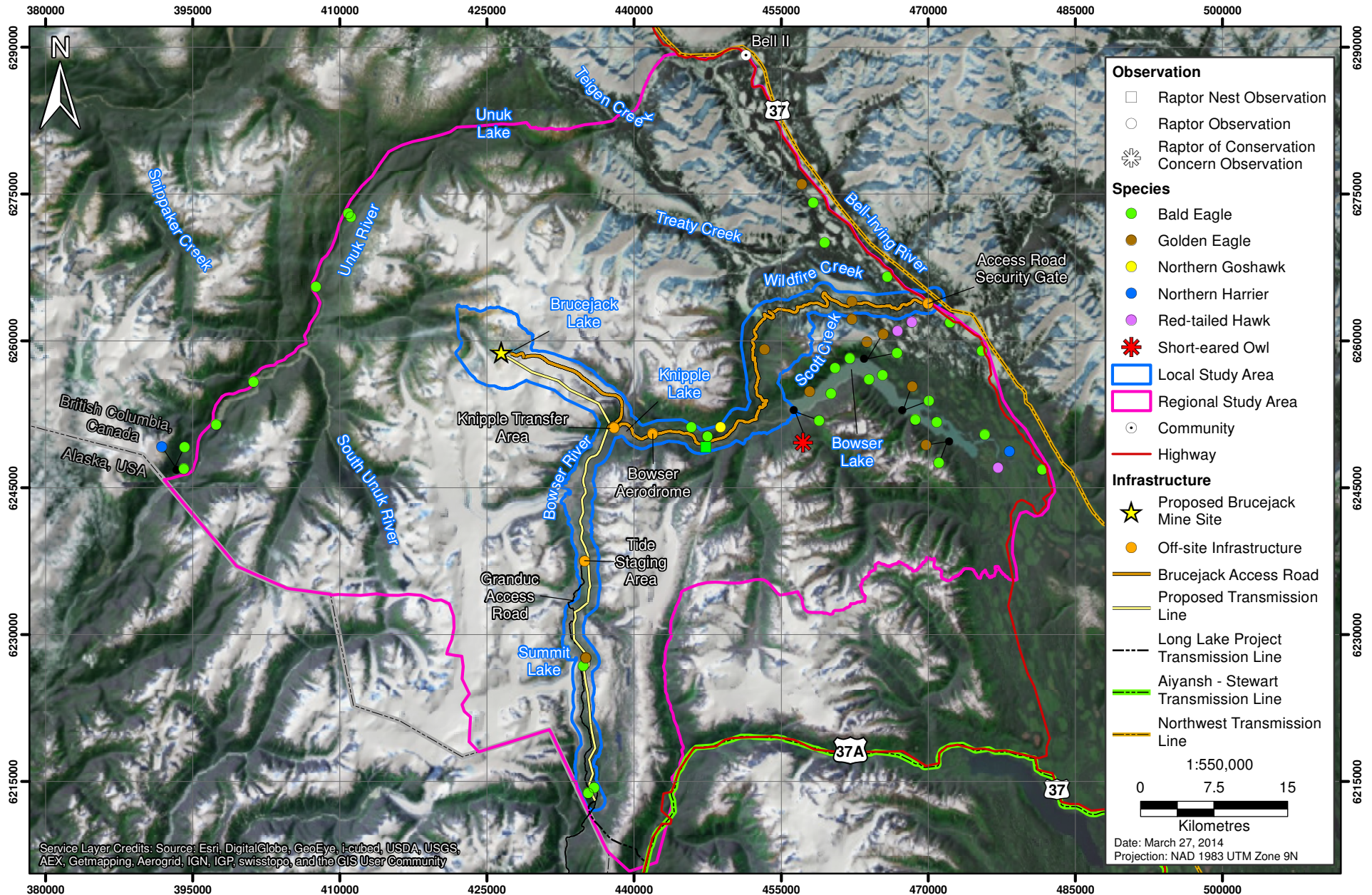
Raptor call-playback and stand-watch surveys were conducted according to provincial standards in the RSA during the summers of 2010 and 2012 (RIC 2001). Incidental observations of raptors were also recorded. Six raptor species were detected within the RSA: northern goshawk, bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), and short-eared owl (*Asio flammeus*; Figure 18.3-10). The short-eared owl is a provincially blue-listed species (BC CDC 2013) and federally designated as Special Concern by COSEWIC and listed on Schedule 1 of SARA (COSEWIC 2008). Suitable short-eared owl nesting habitat was identified in a relatively small area near the mouth of the Bowser River within the LSA. Bald eagles were observed most frequently, followed by golden eagles and red-tailed hawks.

#### 18.3.5.2 Waterbirds

##### Background Information

Waterbirds include waterfowl and wading birds, such as ducks, geese, swans, loons, and grebes, as well as riverine birds such as American dippers and harlequin ducks. Waterbirds are an important game species for resident hunters and Aboriginal peoples. The CIS LRMP identified trumpeter swan (*Cygnus buccinator*) winter habitat as important areas to conserve. Another species, harlequin duck (*Histrionicus histrionicus*), is of particular interest to the Canadian Wildlife Service, as it occupies a unique habitat niche, nesting near fast-flowing rivers and mountain streams (Campbell et al. 1990; Robertson and Goudie 1999; BC MSRM 2002). Migratory waterbirds and their nests are protected under the federal *Migratory Birds Convention Act* (1994) and identifying species of conservation concern meets the obligations of SARA (2002c) and the BC *Wildlife Act* (1996). In addition, waterbirds are often used as indicators of ecosystem and waterbody health and they are an important dietary component for raptor and carnivore species.

**Figure 18.3-10**  
**Raptors Observed during Baseline Surveys**



### Baseline Studies

In 2012, four aerial surveys were conducted according to provincial standards for waterbirds during the breeding and migration periods for waterbirds in northern BC (RIC 1998c, 1998f, 1999c). A total of 28 species were identified and 3,639 individuals were observed. The most commonly observed species were ring-necked duck (*Aythya collaris*), mallard (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), American green-winged teal (*Anas crecca*), and Barrow's goldeneye (*Bucephala islandica*; [Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report).

Three species of conservation concern were observed in 2012 including: harlequin duck (provincially ranked as vulnerable during the non-breeding season), trumpeter swan (which is a species of regional concern), and great-blue heron (which is provincially blue-listed and federally listed as a species of Special Concern under Schedule 1 of SARA; Figure 18.3-11). Eight breeding pairs of harlequin ducks were observed, most of which were within the LSA, along sections of the Bowser River and upper Sulphurets Creek. Two harlequin duck broods were observed in river or backchannel habitat, and the other was located on a high-elevation, glacier-fed lake. Of the 17 trumpeter swans that were observed, approximately half were found during spring staging in pond or marsh habitat near Border Lake, outside the LSA. One great-blue heron was observed during fall staging near Border Lake, in marsh habitat. Both of these species are typically associated with wetlands. Other wetland habitat within the LSA that might support great-blue herons includes areas along Todedada Creek, upper Bell-Irving River, and eastern Bowser River. Riverine habitat associated with large, mature cottonwoods, particularly along Bell-Irving River, Treaty Creek, and the confluence of Bowser Lake and Bowser River, could potentially be used for nesting heron colonies. No evidence of nesting heron colonies was observed in the LSA.

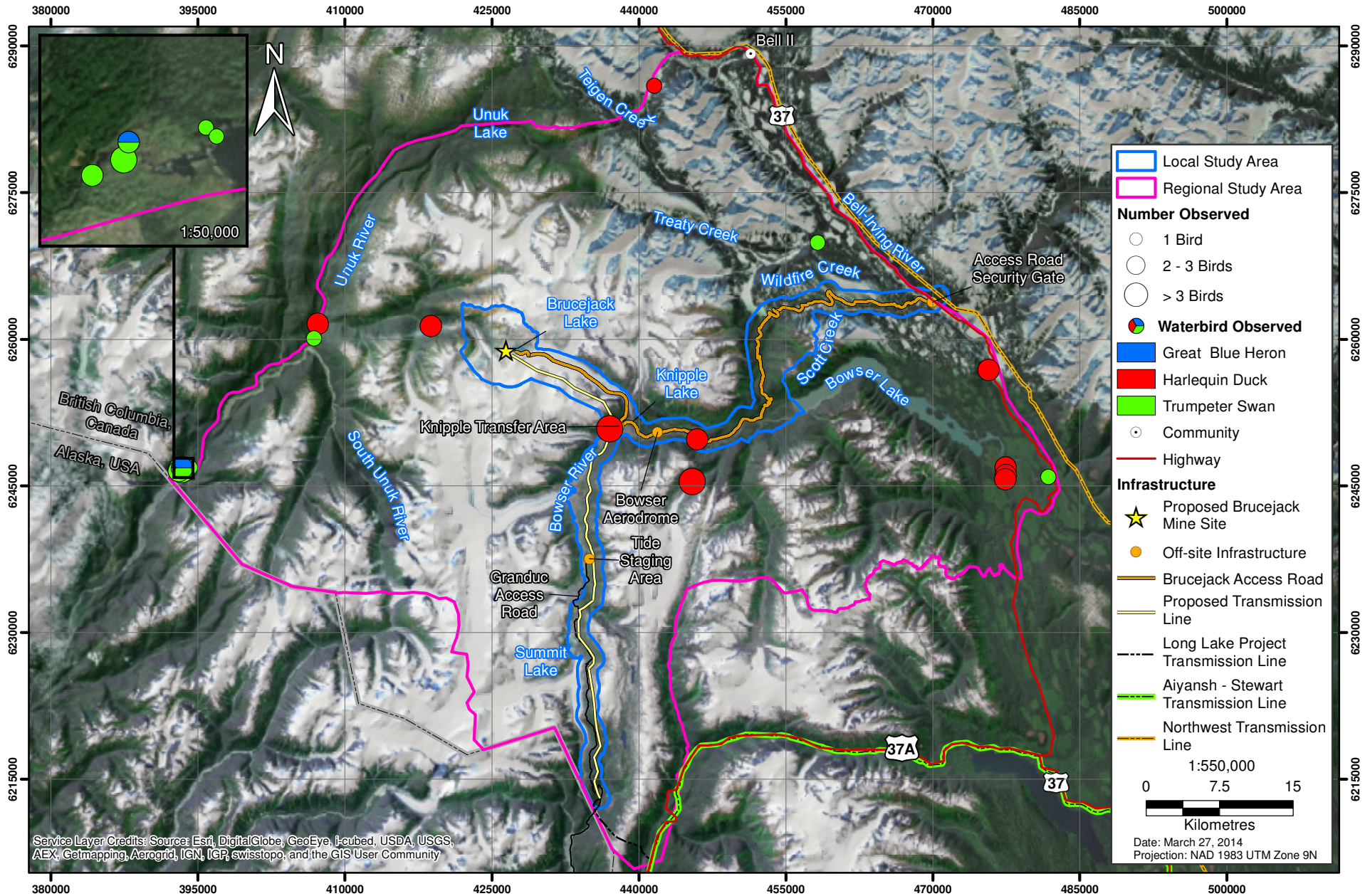
Large abundances of waterbirds were observed during spring staging (533 birds) and fall staging (236 birds) surveys. Important staging habitats include swamps; beaver ponds; shallow lakes; and low flow, meandering backchannels. Staging habitats are found along the Bell-Irving River, Treaty Creek, Bowser River, and the lower Unuk River. These areas are usually the first to become ice-free in the early spring. Large concentrations of waterbirds were observed within the LSA along Bowser River, Knipple Lake, and at the confluence of Bowser River and Bowser Lake during spring (Figure 18.3-12). The majority of fall staging waterbirds were found outside the LSA near Border Lake, along the upper Bell-Irving River, and Snowbank Creek (Figure 18.3-13).

Large abundances of birds were observed during the spring pair survey in June (approximately 2,000 birds observed). A total of 37 broods were observed during the summer in July, the majority belonging to Barrow's goldeneye, mallard, and Canada goose ([Appendix 18-A](#), 2013 Wildlife Habitat Suitability Report). Broods of species of conservation concern that were observed included harlequin ducks and trumpeter swans. The largest concentrations of broods within the LSA occurred along Bowser River and at the west end of Bowser Lake (Figure 18.3-14). Outside the LSA, large concentrations of broods were detected along Treaty Creek, Scott Creek, at the northern end of the Bell-Irving River, and in small lakes along Wildfire Ridge. Breeding habitat was generally associated with calm, low-flowing water bodies including ponds, lakes, and backchannels bordered by dense shrub and tree cover.

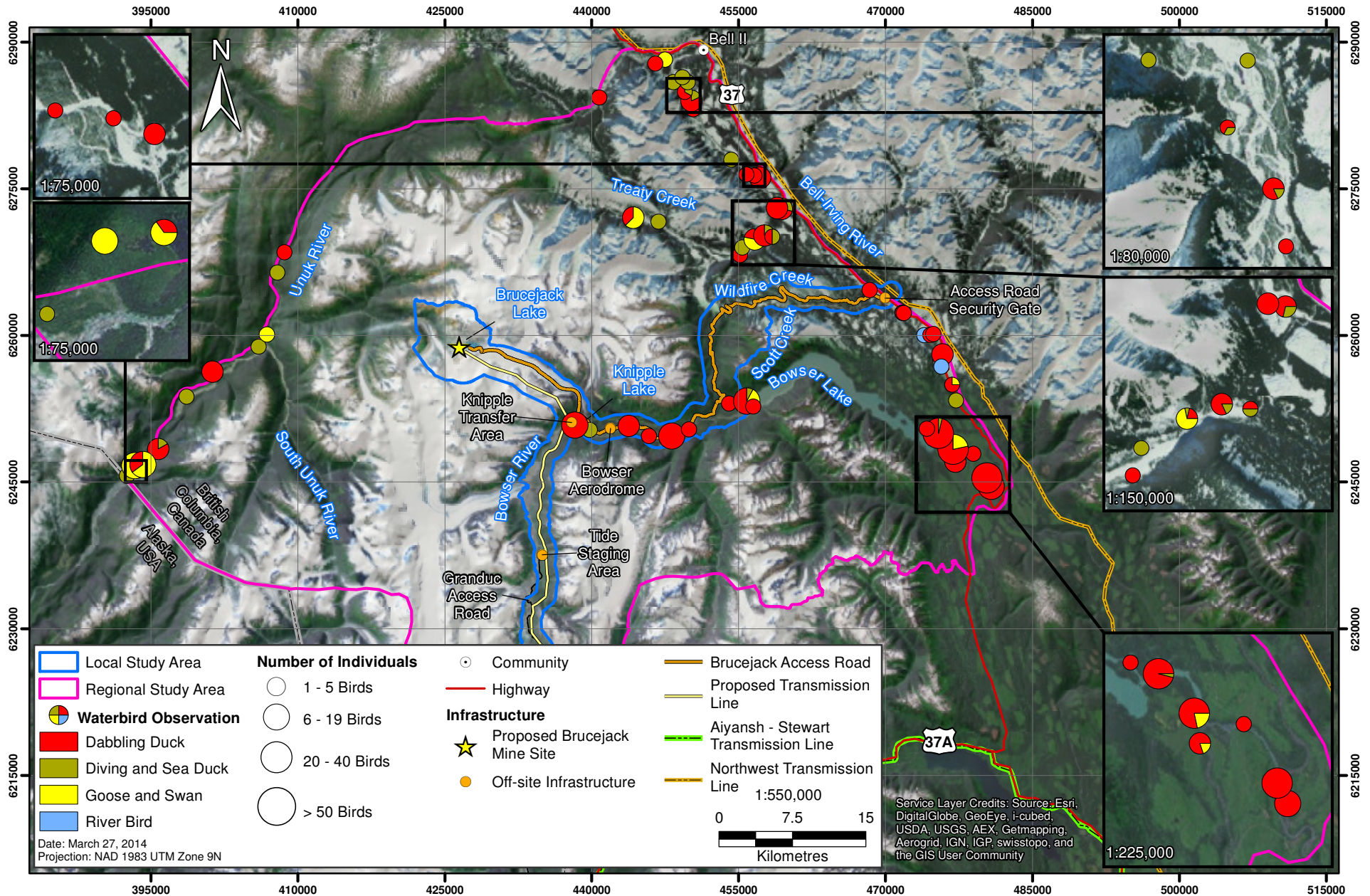
Overall, the area surrounding the proposed Brucejack Mine Site is largely dominated by glaciers and mountain ranges restricting available waterbird habitat. Waterbirds were not observed on Brucejack Lake during baseline studies. Overall, Brucejack Lake has little to no foraging and nesting habitat due to the short growing season. This high-elevation lake has an extensive period of ice coverage and a short growing season, which limits the brooding period.

Figure 18.3-11

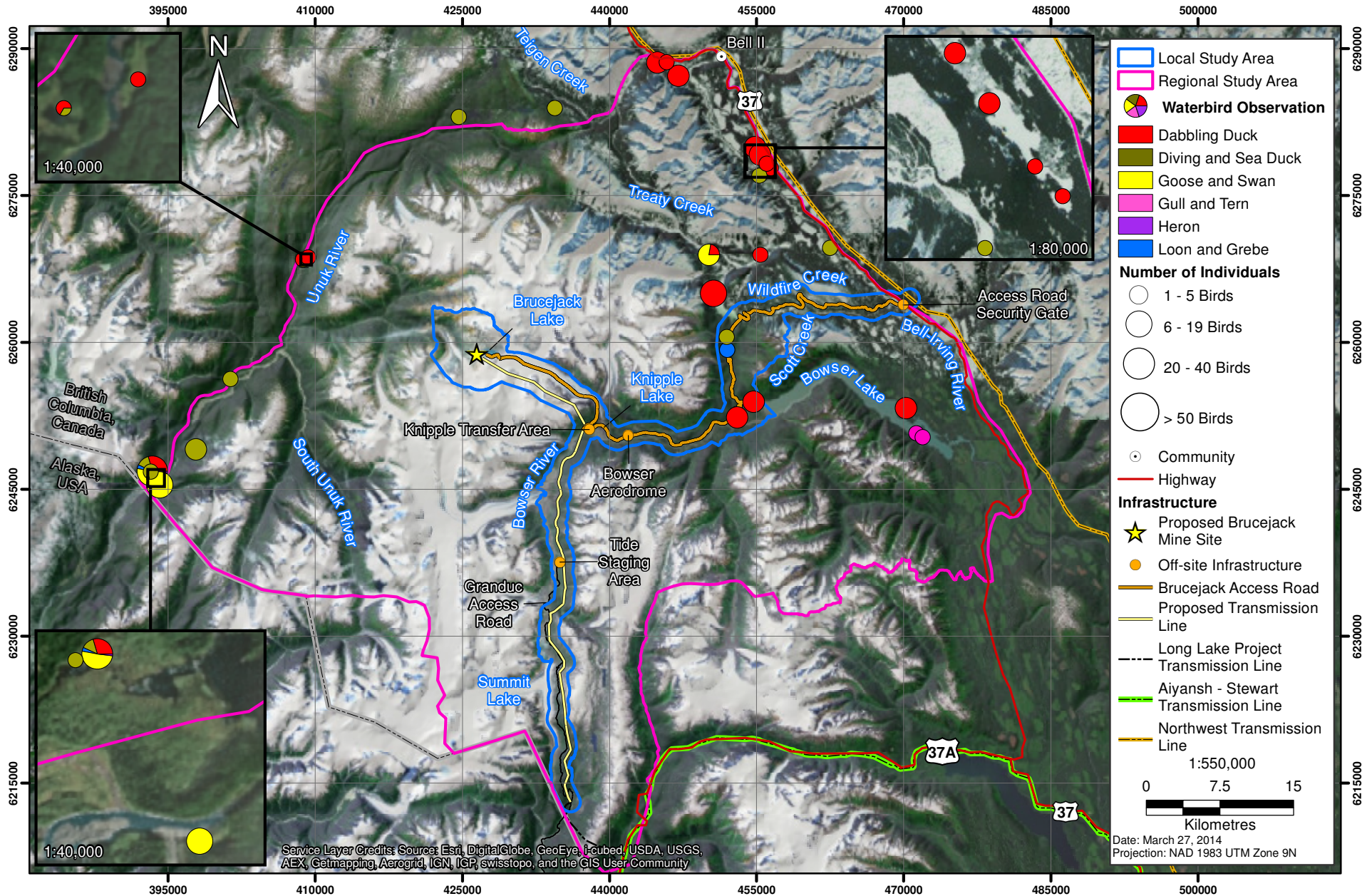
Waterbirds of Conservation Concern Observed during Baseline Surveys



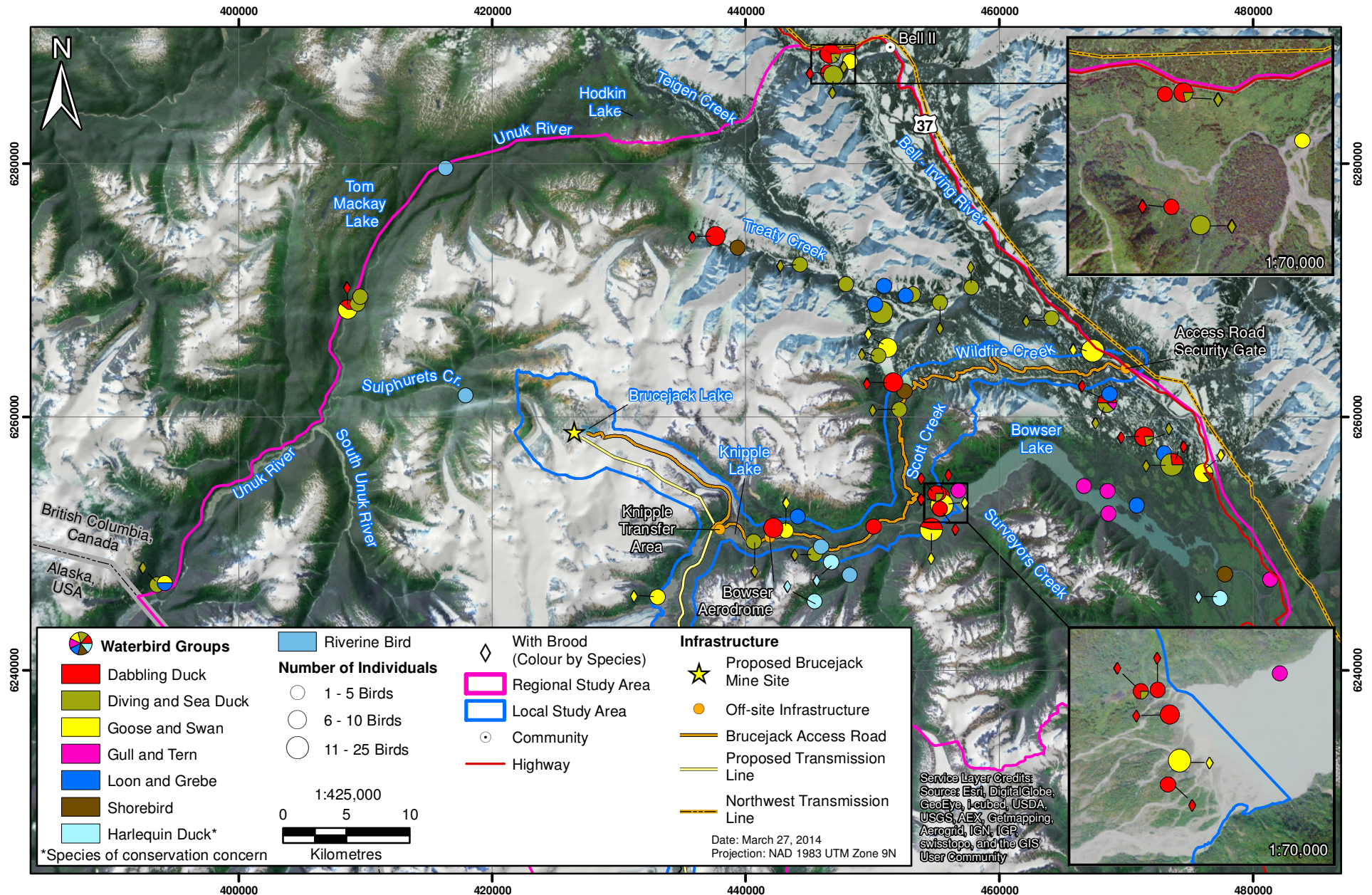
**Figure 18.3-12**  
**Waterbirds Observed during Spring Staging Surveys**



**Figure 18.3-13**  
**Waterbirds Observed during Fall Staging Surveys**



**Figure 18.3-14**  
**Waterbirds Observed during Breeding Surveys**



### 18.3.5.3 Landbirds

#### Background Information

Landbirds include passerines, hummingbirds, swifts, woodpeckers, grouse, and ptarmigan. In addition to migratory bird and species at risk protection, active breeding bird nests are protected under the BC *Wildlife Act* (1996). Baseline studies for landbirds were conducted according to provincial inventory standards (RIC 1999b) in June 2010 and 2012. Landbird distribution, habitat associations, and species composition data provide measures of the health of bird communities as they are considered to be effective indicators of overall ecosystem function and health (Niemi and McDonald 2004). Landbirds perform important ecological roles and often respond rapidly to environmental change (Koch, Derver, and Martin 2011).

#### Baseline Studies

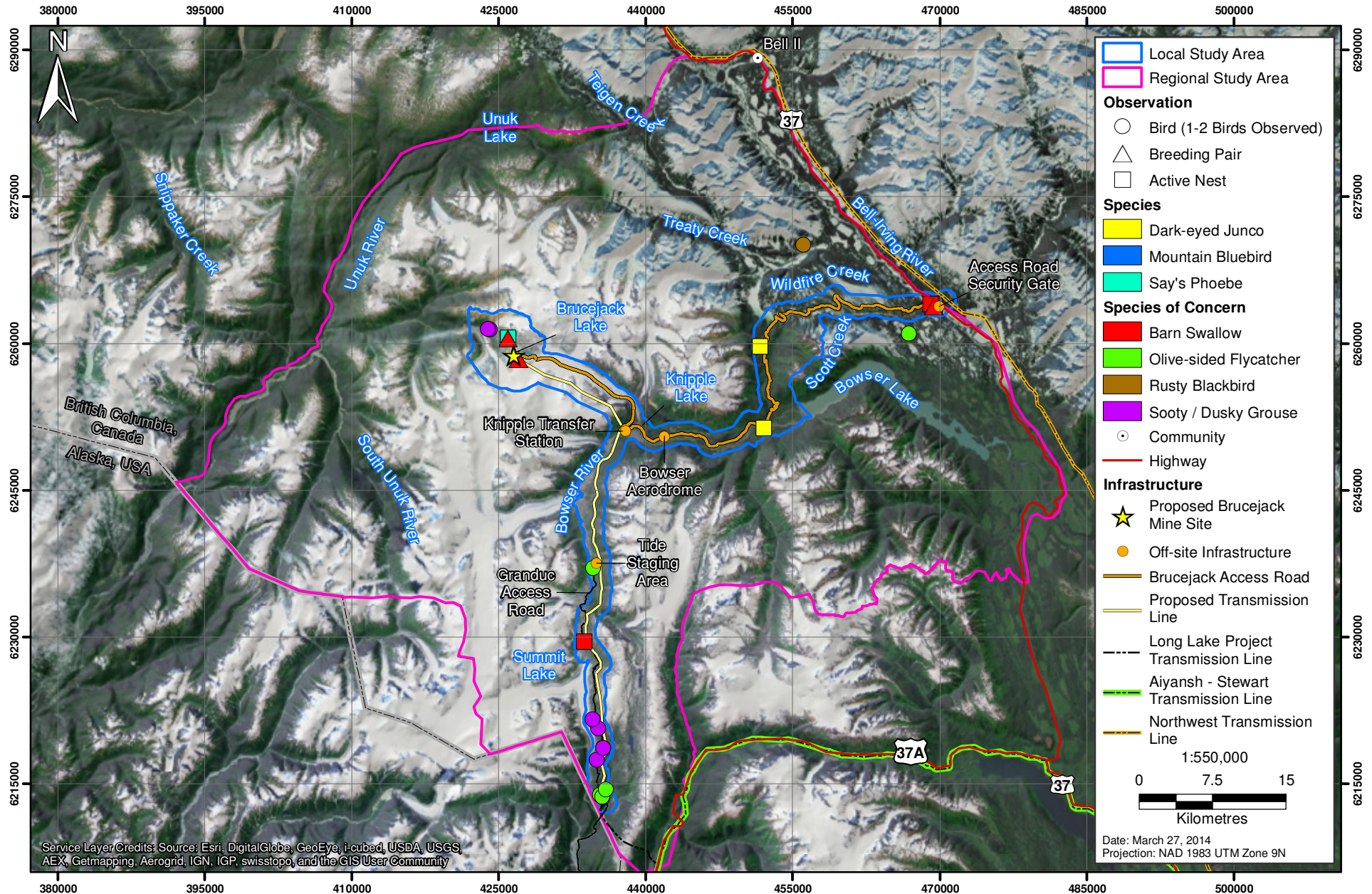
A total of 1,155 individuals representing 55 species were detected during Variable Radius Point Count surveys in the LSA and RSA ([Appendix 18-A](#), 2013 Wildlife Habitat Suitability Report). Areas with the highest average bird abundance and highest species richness were in the eastern half of the LSA: Scott Creek near Todedada Lake, Bowser River, the south end of the LSA along the Brucejack Transmission Line route, and areas within 2 to 5 km of Highway 37. The 10 most commonly detected species were Swainson's thrush (*Catharus ustulatus*), varied thrush (*Ixoreus naevius*), dark-eyed junco (*Junco hyemalis*), ruby-crowned kinglet (*Regulus calendula*), Wilson's warbler (*Cardellina pusilla*), yellow-rumped warbler (*Setophaga coronata*), yellow warbler (*Setophaga petechia*), pine siskin (*Spinus pinus*), Townsend's warbler (*Setophaga townsendi*), and hermit thrush (*Catharus guttatus*).

Four species of conservation concern were observed within the LSA and RSA, all of which have been provincially listed as Special Concern due to population decline: olive-sided flycatcher (*Contopus cooperi*), rusty blackbird (*Euphagus carolinus*), barn swallow (*Hirundo rustica*), and the sooty grouse (*Dendragapus fuliginosus*). The olive-sided flycatcher (SARA: Threatened) and rusty blackbird (SARA: Special Concern), are listed on Schedule 1 of SARA. The olive-sided flycatcher was observed in the LSA along the Brucejack Transmission Line and within the eastern RSA south of the exploration access road. The rusty blackbird was observed within the eastern RSA adjacent to Treaty Creek. The barn swallow has been assessed by COSEWIC as Threatened, but does not have a SARA Schedule at the time of writing.

Active bird nests are protected under the *Wildlife Act* (1996). Six nests were observed within the LSA during Variable Radius Point Counts in 2010 and 2012 (Figure 18.3-15). Nests of three species (barn swallow, dark-eyed junco, and Say's phoebe (*Sayornis saya*)) were found in 2010, and a mountain bluebird nest was found in 2012. Barn swallows have adapted to living in urban areas and often build nests on vertical surfaces of human-made structures, such as under the eaves of buildings, in culverts, and under bridges. Four barn swallow nests were found on infrastructure within the LSA.

Fewer breeding pairs and fewer species of landbirds were detected in high elevation alpine CMA and BAFA BEC zones, which are the BEC zones where the proposed Brucejack Mine Site is located. These alpine areas have persistent snow cover limiting available nesting habitat for breeding birds. The pattern of low bird abundance in alpine areas parallels findings of low abundance and species richness of alpine bird communities in general (Martin 2001). The alpine bird community does, however, support characteristic species that were only detected in the higher elevation CMA BEC zone (Martin 2001; Rescan 2013), such as Say's phoebe and American pipit (*Anthus rubescens*).

**Figure 18.3-15**  
**Landbird Breeding Observations and Species of Conservation Concern**



On average across all BEC zones, more species ( $1.2 \pm 0.54$ ) and more breeding pairs ( $2.3 \pm 0.90$ ) were detected along roadside Variable Radius Point Count stations than at non-roadside stations (Appendix 18-A, 2013 Wildlife Characterization Baseline Report). Roadside habitat is often associated with dense, shrubby vegetation and exposed areas of grasses and forbs, which provide preferred nesting and foraging habitat for some bird species such as Swainson's thrush and yellow-rumped warbler (*Setophaga coronata*; Hutto et al. 1995; Mack and Yong 2000). The BEC zone within non-roadside habitat that had the greatest average number of territories and average species richness was ICH. Breeding was confirmed in the CMA, ICH, and BAFA BEC zones.

### 18.3.6 Amphibian (Western Toad) Characterization

The valley-bottom floodplains and large wetland drainage systems in the RSA provide suitable habitat for amphibians. Western toads (*Anaxyrus boreas*) are a federally listed species of Special Concern, protected under Schedule 1 of SARA, and are blue-listed in BC. Hence, the wildlife characterization for amphibians focused on western toad (Appendix 18-A, 2013 Wildlife Characterization Baseline Report).

#### 18.3.6.1 Western Toad

##### Background Information

The western toad is protected under the BC *Wildlife Act* (Pahlke, McPherson, and Marshall 1996), which states that wildlife cannot be killed, collected, or held in captivity without a permit. Federally, it has been designated a species of Special Concern on Schedule 1 of SARA (COSEWIC 2002a; BC CDC 2013). The western toad is also red-listed as near threatened by the International Union for Conservation of Nature, and is the only international red-listed amphibian in Canada (Wind and Dupuis 2002; IUCN 2013). In BC it is considered secure but it is afforded protection under the *Wildlife Act* and has been given a relatively high priority rating of 2 for goal 2 of BC's Conservation Framework, namely preventing native species from becoming at risk.

BC has recognized the importance of protecting wetland breeding sites because of the key role they play in supporting source populations of western toads for surrounding areas (BC MWLAP 2004b). Preventing migratory barriers between breeding areas is also important for western toads (Carr and Fahrig 2001). Western toads are one of the few amphibian species that may occupy alpine areas and can be found from sea level to possibly 3,660 masl (COSEWIC 2002a). Western toads are capable of moving over 5 km between breeding sites; occasional long-distance movements of up to 7.2 km have been noted for this species (Wind and Dupuis 2002). Young toads (toadlets) spend the first period of their terrestrial lives within the riparian area, eventually dispersing upland. Little is known of the mechanisms that determine the direction and magnitude of toadlet dispersal. Maintaining breeding habitat and connectivity at a regional scale is a management priority for western toads because of their long distance dispersal, making them particularly vulnerable to human disturbance and activities.

##### Baseline Studies

The LSA contains suitable western toad habitat in many locations due to the low elevation riparian habitat connected to watercourses, waterbodies, and wetlands (e.g., the Bower River, Bowser Lake, Wildfire Creek, Scott Creek, Knipple Lake, Todedada Creek, Todedada Lake, and the Bell-Irving River), flat forest lands, and ditches associated with historical forestry access roads.

Surveys were conducted within the LSA and in important habitat just outside of the LSA in 2012. The focus of baseline surveys for the Project were western toads; therefore, field methods for detecting western toads were adapted from standard amphibian sampling techniques and western toad monitoring programs (Pyare 2005). These standards were used within the context of the RISC provincial standards (RIC 1998e).

In July, 2012, 66 open-water sites were surveyed aerially to assess their suitability for western toad breeding (Figure 18.3-16; Appendix 18-A, Wildlife Characterization Baseline Report). Twenty-four of the 66 sites were selected for additional ground surveys based on characteristics that made them likely to support western toad breeding. During subsequent ground-based surveys in July 2012, western toads were observed at 10 sites (five sites within the LSA; Figure 18.3-16), seven of which were identified as breeding sites. Two additional breeding sites were observed incidentally; therefore, a total of nine western toad breeding ponds were confirmed.

Eight out of the nine breeding sites were in the low elevation ICH BEC zone. Breeding sites were confirmed along Scott Creek, Wildfire Creek, and north of Bowser Lake. Six western toad breeding sites were located within 2 km of the exploration access road, two of which were observed less than 250 m from the road near Scott Creek and Todedada Creek (Figure 18.3-16).

The timing of breeding at sites within the RSA varied, with the first observations of tadpoles incidentally on July 3, 2011 (at an elevation of 612 masl), and the last observation of toadlets during surveys on August 30, 2012 (at an elevation of 646 masl).

During baseline surveys, the Columbia spotted frog (*Rana luteiventris*) was also confirmed in the RSA and LSA, which is provincially yellow listed and identified as Not at Risk by COSEWIC. Columbia spotted frogs were breeding in several ponds within the LSA. Columbia spotted frogs select a much broader band of breeding ponds in both elevation and habitat type than western toads; while only one breeding site was shared between Columbia spotted frog and western toad, many were in close proximity (Figure 18.3-16).

Confirmed western toad breeding in the LSA is consistent with previous studies conducted for the KSM Project which identified three western toad breeding sites along Teigen Creek and in an unnamed lake connected to Teigen Creek (Rescan 2010b).

#### 18.4 ESTABLISHING THE SCOPE OF THE EFFECTS ASSESSMENT FOR WILDLIFE

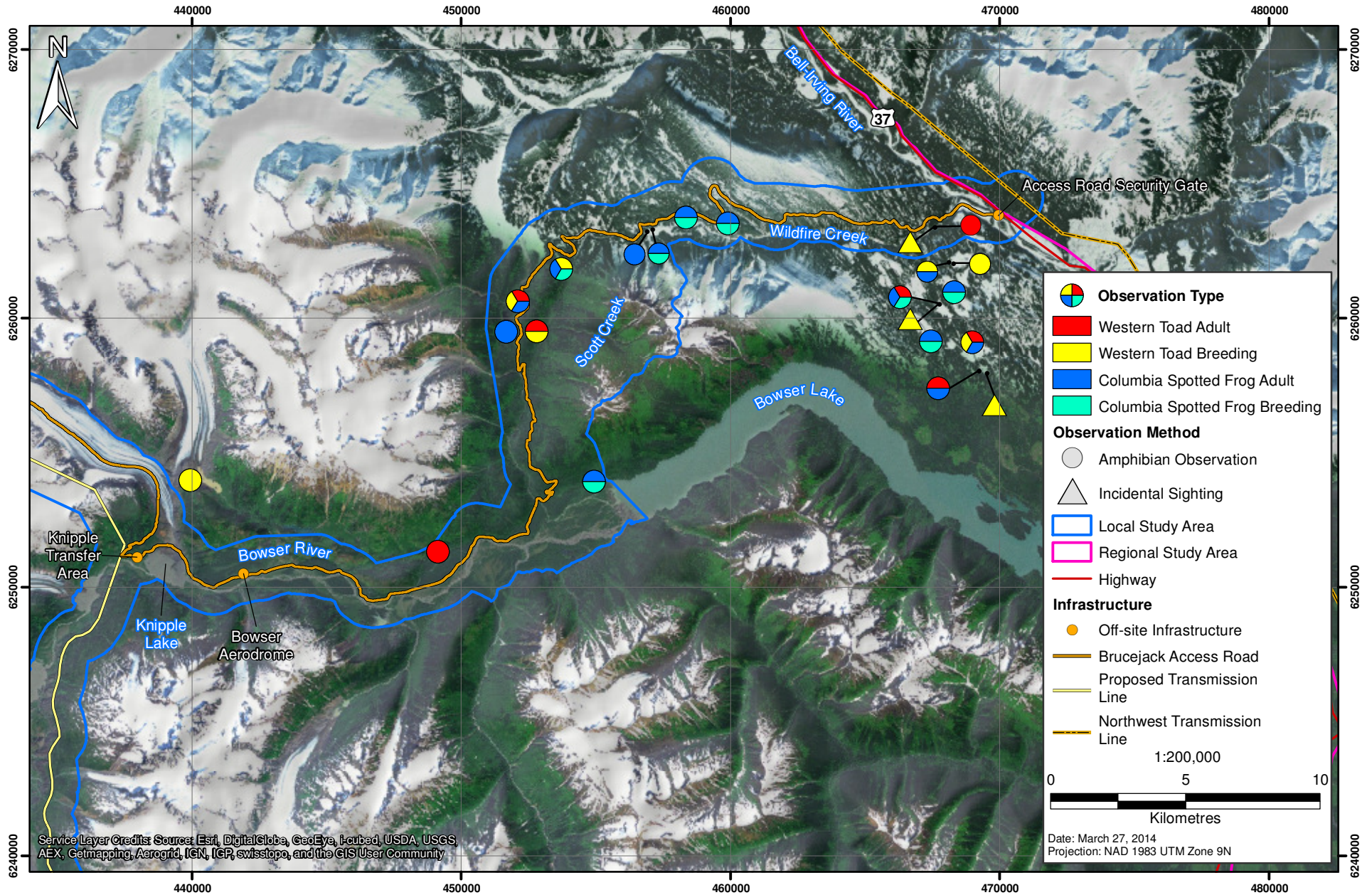
This section of the assessment of wildlife and wildlife habitat includes a description of the scoping process used to identify potentially affected VCs, select assessment boundaries, and identify the potential effects of the Project that are likely to arise from the Project's interaction with a receptor VC. Scoping is fundamental to focusing the Application/EIS on those issues where there is the greatest potential to cause significant adverse effects. The scoping process for the assessment of wildlife and wildlife habitat consisted of the following four steps:

- *Step 1:* undertaking an issues scoping process to select wildlife receptor VC subcomponents (hereafter referred to as wildlife VCs) based on a consideration of the Project's potential to interact with a VC;
- *Step 2:* consideration of feedback on the results of the scoping process from technical experts and the EA Working Group<sup>2</sup>;
- *Step 3:* definition of assessment boundaries for wildlife VCs; and
- *Step 4:* identification of key potential effects on wildlife VCs.

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<sup>2</sup> The EA Working Group is a forum for discussion and resolution of technical issues associated with the proposed Project, as well as providing technical advice to the BC EAO and Canadian Environmental Assessment Agency, which remain ultimately responsible for determining significance. It comprises representatives of provincial, federal, and local government, and Aboriginal groups.

**Figure 18.3-16**  
**Amphibian Observations during Baseline Surveys**



These steps are described in detail below.

The linkages between predictive study results from intermediate components and the receptor VCs addressed by the effects assessment for wildlife are illustrated in Figure 6.4-1 (Chapter 6, Assessment Methodology). The following intermediate components will be used to support the effects assessment for wildlife:

- air quality;
- noise; and
- water quality.

#### **18.4.1 Selecting Receptor Valued Components**

Selecting receptor VCs for assessment is undertaken to focus the Application/EIS on the issues of highest concern. Receptor VCs are specific attributes of the biophysical and socio-economic environments that have environmental, social, economic, heritage, or health significance. Receptor VCs also have the potential to be indirectly affected by changes in the baseline condition of other environmental components thereby acting as receptors of that change. Indirect effects may, in turn, also affect the baseline condition of the receptor VC. To be considered for assessment, a component must be of recognized importance to society, the local community, or the environmental system, and there must be a perceived likelihood that the receptor VC will be affected by the proposed Project. Receptor VCs are scoped during consultation with key stakeholders, including Aboriginal communities and the EA Working Group. Consideration of certain receptor VCs may also be a legislated requirement, or known to be a concern because of previous project experience.

As described in Section 6.4.1.1, Scoping Potential Interaction between the Project and Candidate Components, a scoping exercise was conducted during the development of the draft Application Information Requirements (AIR) to explore potential Project interactions with candidate receptor VCs, and to identify the key potential adverse effects associated with that interaction. The results of the scoping exercise were circulated for review and approval by the EA Working Group, and feedback from that process was integrated into the Application/EIS.

Assessing the effects on wildlife as a receptor VC is sufficiently broad to “split” into subcomponents and define the VCs more narrowly as individual species (e.g., moose) or species groups (e.g., raptors). A number of wildlife receptor VC subcomponents were selected to focus the effects assessment. While individual species and species groups are considered subcomponents to the more general wildlife subject area, effects assessment including determination of significance are completed individually for each subcomponent. For simplicity, wildlife receptor VC subcomponents will be hereafter referred to as wildlife VCs. These species or focal groups were chosen because they met one or more of the following criteria:

- species at risk or of conservation concern;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies such as the BC MFLNRO, the FRPA (2002c), the BC Conservation Framework priority, or the Canadian Wildlife Service;
- species identified as having a strong biological importance for the functioning of the ecosystem in the Project area, including importance as keystone, indicator, and/or umbrella species; and/or
- species of cultural, social, and/or economic importance.

Each potential wildlife VC was screened for inclusion in the Application/EIS and interests and issues that governments (Aboriginal and non-Aboriginal), local interest groups, and the general public identified during the engagement process were considered in VC selection. VCs were selected based on the results of these activities, reflecting a balanced and knowledgeable synthesis of a wide range of information. Any species or wildlife group considered as a VC is known to occur in the Project area and is reasonably likely to be affected by, or have an influence on, the Project.

The following sections review the selection criteria used to identify selected VCs and include a rationale for their inclusion in the Application/EIS. The following section also discusses potential VCs that were considered, but ultimately not included in the effects assessment, and reasons for their exclusion.

#### *Species of Conservation Concern or of Regional Importance*

The following legislation, land and resource use plans, and reports were consulted to identify species at risk or of conservation concern, species or focal groups of regional importance, or those of particular interest to regulatory agencies:

- COSEWIC (2010);
- SARA (2002c);
- *Migratory Birds Convention Act* (G. M. Ward 1994);
- *BC Wildlife Act* (Pahlke, McPherson, and Marshall 1996);
- BC FRPA (2002c);
- BC Red- and Blue-list (BC CDC 2013);
- BC Conservation Framework (BC CDC 2013);
- Nass South SRMP (BC MFLNRO 2012); and
- CIS LRMP (BC ILMB 2000).

#### *Species of Biological Importance*

Species were considered during the VC selection process based on the role that a species or group plays in the health of its local ecosystem, including its role as a keystone, indicator, or umbrella species. Keystone species are those that have relatively low population numbers compared to their importance in maintaining a balanced ecosystem (Helfield and Naiman 2006). For example, moose are considered a biologically important species, as they are capable of modifying the local ecology, especially wetland vegetation (McLaren et al. 2000).

The composition and/or health of an ecosystem can be assessed by analyzing the presence, fitness, or changes occurring in the population of an “indicator species” (Niemi and McDonald 2004). As a result, assessing the potential for effects on indicator species, such as the American marten (Fecske, Jenks, and Smith 2002) or amphibians (Collins and Storfer 2003) can lead to knowledge about the state of the local ecosystem or general environmental health. Umbrella species, such as grizzly bear, were also considered because an evaluation of the effects on these species results, directly or indirectly, in the evaluation and protection of many other species with similar or smaller home ranges or that require similar life requisites as the umbrella species (Roberge and Angelstam 2004).

#### *Species of Cultural, Social, or Economic Importance*

Aboriginal traditional knowledge/traditional use (TK/TU) can provide valuable information on the historical and current presence and distribution of wildlife, as well as identify species or groups of

cultural importance within or adjacent to a project area. A goal of the Application/EIS was to integrate TK/TU into Project development wherever possible.

TK/TU information was sought from the Aboriginal groups noted on the Section 11 Order and includes information from the Skii km Lax Ha and the Tahltan Nation. Following efforts to engage First Nations in TK/TU studies, information was also obtained through desk-based research using publicly available sources. The Skii km Lax Ha worked collaboratively to provide primary source information in the form of specific TK/TU sites and areas and a report has been developed based on those discussions. Information can be found in Chapter 25, Assessment of Potential Effects to Current Use of Lands and Resources for Traditional Purposes, and [Appendices 25-A, 25-B, and 25-C](#).

**18.4.1.1 Potential Interactions between the Project and Wildlife**

Table 18.4-1 provides an impact scoping matrix of Project components and the wildlife receptor VCs that includes Project components and activities that have a possible or likely interaction with wildlife, as well as Project components and activities not expected to interact with wildlife. A full impact scoping matrix for all intermediate and receptor VCs is provided in Table 6.4-1 in Chapter 6, Assessment Methodology.

**Table 18.4-1. Interaction of Project Components and Physical Activities with All Wildlife**

Project Components and Physical Activities by Phase	All Wildlife
<i>Construction Phase</i>	
Activities at existing adit	
Air transport of personnel and goods	
Avalanche control	
Chemical and hazardous material storage, management and handling	
Construction of back-up diesel power plant	
Construction of Bowser Aerodrome	
Construction of detonator storage area	
Construction of electrical 3-pole tie in to BC Hydro grid	
Construction of electrical substation at mine site area	
Construction of equipment laydown areas	
Construction of helicopter pad	
Construction of incinerators	
Construction of Knipple Transfer Area	
Construction of local site roads	
Construction of mill building (electrical induction furnace, backfill paste plant, warehouse, and mill/concentrator)	
Construction of mine portal and ventilation shafts	
Construction of Brucejack Camp	
Construction of ore conveyer	
Construction of tailings pipeline	
Construction and decommissioning of Tide Staging Area construction camp	
Construction of truck shop	

(continued)

**Table 18.4-1. Interaction of Project Components and Physical Activities with All Wildlife (continued)**

Project Components and Physical Activities by Phase	All Wildlife
<b>Construction Phase (cont'd)</b>	
Construction and use of sewage treatment plant and discharge	
Construction and use of surface water diversions	
Construction of water treatment plant	
Development of underground portal and facilities	
Employment and labour	
Equipment maintenance/machinery and vehicle refuelling/fuel storage and handling	
Explosives storage and handling	
Grading of the mine site area	
Helicopter use	
Installation and use of Project lighting	
Installation of surface and underground crushers	
Installation of transmission line and associated towers	
Machinery and vehicle emissions	
Potable water treatment and use	
Pre-production ore stockpile construction	
Procurement of goods and services	
Quarry construction	
Solid waste management	
Transportation of workers and materials	
Underground water management	
Upgrade and use of exploration access road	
Use of Granduc Access Road	
<b>Operation Phase</b>	
Air transport of personnel and goods and use of Bowser Aerodrome	
Avalanche control	
Backfill paste plant	
Backup diesel power plant	
Bowser Aerodrome	
Brucejack Access Road use and maintenance	
Brucejack Camp	
Chemical and hazardous material storage, management, and handling	
Concentrate storage and handling	
Contact water management	
Detonator storage	
Discharge from Brucejack Lake	
Electrical induction furnace	

(continued)

**Table 18.4-1. Interaction of Project Components and Physical Activities with All Wildlife (continued)**

Project Components and Physical Activities by Phase	All Wildlife
<i>Operation Phase (cont'd)</i>	
Electrical substation	
Employment and labour	
Equipment laydown areas	
Equipment maintenance/machine and vehicle refuelling/fuel storage and handling	
Explosives storage and handling	
Helicopter pad(s)	
Helicopter use	
Knipple Transfer Area	
Machine and vehicle emissions	
Mill building	
Non-contact water management	
Ore conveyer	
Potable water treatment and use	
Pre-production ore storage	
Procurement of goods and services	
Project lighting	
Quarry operation	
Sewage treatment and discharge	
Solid waste management/incinerators	
Subaqueous tailings disposal	
Subaqueous waste rock disposal	
Surface crushers	
Tailings pipeline	
Truck shop	
Transmission line operation and maintenance	
Underground backfill tailing storage	
Underground backfill waste rock storage	
Underground crushers	
Underground: drilling, blasting, excavation	
Underground explosives storage	
Underground mine ventilation	
Underground water management	
Use of mine site area haul roads	
Use of portals	
Ventilation shafts	

(continued)

**Table 18.4-1. Interaction of Project Components and Physical Activities with All Wildlife (continued)**

Project Components and Physical Activities by Phase	All Wildlife
<i>Operation Phase (cont'd)</i>	
Warehouse	
Waste rock transfer pad	
Water treatment plant	
<i>Closure Phase</i>	
Air transport of personnel and goods	
Avalanche control	
Chemical and hazardous material storage, management, and handling	
Closure of mine portals	
Closure of quarry	
Closure of subaqueous tailing and waste rock storage (Brucejack Lake)	
Decommissioning of Bowser Aerodrome	
Decommissioning of backup diesel power plant	
Decommissioning of Brucejack Access Road	
Decommissioning of camps	
Decommissioning of diversion channels	
Decommissioning of equipment laydown	
Decommissioning of fuel storage tanks	
Decommissioning of helicopter pad(s)	
Decommissioning of incinerators	
Decommissioning of local site roads	
Decommissioning of mill building	
Decommissioning of ore conveyer	
Decommissioning of Project lighting	
Decommissioning of sewage treatment plant and discharge	
Decommissioning of surface crushers	
Decommissioning of surface explosives storage	
Decommissioning of tailings pipeline	
Decommissioning of transmission line and ancillary structures	
Decommissioning of underground crushers	
Decommissioning of waste rock transfer pad	
Decommissioning of water treatment plant	
Employment and labour	
Helicopter use	
Machine and vehicle emissions	
Procurement of goods and services	

(continued)

**Table 18.4-1. Interaction of Project Components and Physical Activities with All Wildlife (completed)**

Project Components and Physical Activities by Phase	All Wildlife
<i>Closure Phase (cont'd)</i>	
Removal or treatment of contaminated soils	
Solid waste management	
Transportation of workers and materials (mine site area and access roads)	
<i>Post-closure Phase</i>	
Discharge from Brucejack Lake	
Employment and labour	
Environmental monitoring	
Procurement of goods and services	
Subaqueous tailing and waste rock storage	
Underground mine	

**Notes:**

*White = interaction not expected between Project components/physical activities and a receptor VC.*

*Grey = possible interaction between Project components/physical activities and a receptor VC.*

*Black = likely interaction between Project components/physical activities and a receptor VC.*

Interactions between the Project and wildlife were assigned a colour code as follows:

- not expected (white);
- possible (grey); and
- likely (black).

Interactions coded as not expected (white) are considered to have no potential for adverse effects on a receptor VC, and are not considered further.

**18.4.1.2 Consultation Feedback on Receptor Valued Components**

The proposed Project is located within the Nass Area as defined in the *Nisga’a Final Agreement (NFA)* (NLG, BC, and GOC 1998), as well as within the traditional territories of the Skii km Lax Ha and Tahltan Nation (Chapter 26; Section 26.2). Nisga’a Nation is referred to separately in Chapter 27 (Nisga’a Nation Treaty Rights, Interests, and Information Requirements).

Skii km Lax Ha

The Skii km Lax Ha currently harvest moose, grizzly bear and mountain goat. In addition, the Skii km Lax Ha actively trapped for beaver, marten and wolverine. The Skii km Lax Ha advise they have not recently trapped in the area due to their involvement in a number of power and mineral exploration projects in their territory (Chapter 25; Section 25.3.4.2).

Tahltan Nation

To date, the Tahltan have provided limited information on the use of wildlife resources in the wildlife RSA. Tahltan have expressed concern with road effects on moose corridors, regarding vehicle-wildlife collisions and cumulative effects of mine development. The eastern most segment of the Brucejack Access Road, approximately the first nine kilometres of road branching off to the west of Highway 37,

is within Tahltan territory (Chapter 26; Section 26.2.2.1). Neither the Mine Site nor the Brucejack Transmission Line are within Tahltan traditional territory; however, within the wildlife RSA, Treaty Creek and Wildlife Creek are within the Tahltan traditional territory (Figure 26.2-2).

#### Nisga'a Nation

To date, information on hunting activities in the wildlife RSA has not been provided by the Nisga'a Nation. The Nisga'a Nation did provide several wildlife reports on moose, grizzly bear, and mountain goats contributing to the baseline knowledge of the aforementioned wildlife species. More information on Nisga'a Nation's interests is detailed in Chapter 27.

#### 18.4.1.3 Summary of Valued Components Included/Excluded in the Application/EIS

The wildlife VCs selected for the Project are presented in Table 18.4-2, along with a rationale for their inclusion in the assessment. Potential VCs that were considered but were not included in the assessment are presented in Table 18.4-3, with a rationale for their exclusion. The group or body which identified each potential VC is also referenced in the tables, including Aboriginal groups, government, public/stakeholders, or the impact matrix (e.g., legislation, technical expertise).

**Table 18.4-2. Wildlife Valued Components Included in the Application/EIS**

Wildlife Group	Valued Component	Identified by*				Rationale for Inclusion
		AG	G	P/S	IM	
Ungulates	Moose	x	x	x	x	Moose are identified as a culturally important and hunted species for Skii km Lax Ha (Rescan 2009a). Moose were identified as a species requiring increased management consideration in land management plans, including the Nass South SRMP (BC MFLNRO 2012), and CIS LRMP (BC ILMB 2000). Moose is also a biologically important species. High and Moderately High moose winter habitat is located in the RSA and moose presence was confirmed during baseline studies. Candidate moose UWRs have been identified in the RSA and LSA.
	Mountain Goat	x	x	x	x	Mountain goat is a culturally important and hunted species for Skii km Lax Ha (Rescan 2009a). Mountain goat have been identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012), and CIS LRMP (BC ILMB 2000). Mountain goats are provincially listed as S4 and Yellow (apparently secure), globally listed as G5 (demonstrably widespread, abundant, and secure), and BC Conservation Framework Priority-listed as 1 (highest conservation priority) due to a ranking of 1 on the Conservation Framework goal of "Prevent species and ecosystems from becoming at risk" (BC CDC 2013). Mountain goats use habitats throughout the RSA, wherever suitable high elevation habitat occurs.
Bears	Grizzly Bear	x	x	x	x	Grizzly bear are provincially blue-listed, federally listed as a species of Special Concern, and are a species of cultural importance for Skii km Lax Ha (Rescan 2009a). Grizzly bears are biologically important as an umbrella species. Economically important to local hunters and guide outfitters. Identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012), and CIS LRMP (BC ILMB 2000). Foraging habitat for grizzly bear for vegetation resources and spawning salmon reaches exist in the LSA and RSA.

(continued)

**Table 18.4-2. Wildlife Valued Components Included in the Application/EIS (completed)**

Wildlife Group	Valued Component	Identified by*				Rationale for Inclusion
		AG	G	P/S	IM	
Furbearers	American Marten	x		x	x	American marten was identified as a culturally important and trapped species for Skii km Lax Ha and Nisga’a Nation (Rescan 2009a, 2012). Economically important furbearer to local trappers. Identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012) and CIS LRMP (BC ILMB 2000). Biologically important as an indicator species. Presence was confirmed during baseline studies.
Groundhogs	Hoary Marmot	x				Groundhog (hoary marmot) was identified as a culturally important and hunted species for Skii km Lax Ha and Nisga’a Nation and their presence was confirmed during baseline studies (Rescan 2009a, 2012).
Bats	Bat species at risk		x		x	Provincially blue-listed northern long-eared myotis could occur within the LSA and RSA. The silver-haired bat was identified by BC MOE as regionally important in the Skeena Region because of concerns with maintaining maternal roosts in tree cavities. The little brown myotis is listed as Endangered by COSEWIC (COSEWIC 2012c) over concerns with white-nose syndrome. Keen’s long-eared myotis is red-listed in BC and in BC’s Conservation Framework as priority-listed as goal 1. Because of the lack of regional knowledge about this wildlife group and their ability to habituate to anthropogenic structures, bats are included as a VC.
Birds	Waterbirds	x	x		x	Individual birds, eggs and active nests are protected under <i>Migratory Birds Convention Act</i> (G. M. Ward 1994) and <i>Wildlife Act</i> (Pahlke, McPherson, and Marshall 1996). There were 28 waterbird species confirmed on waterbodies during baseline studies, including wetland birds (e.g., ducks, geese), cavity-nesting waterfowl (e.g., goldeneyes), and riverine birds (e.g., harlequin duck).
	Landbirds	x	x		x	Individual birds, eggs, and active nests are protected under the <i>Migratory Birds Convention Act</i> (G. M. Ward 1994) and <i>Wildlife Act</i> (Pahlke, McPherson, and Marshall 1996). This VC includes culturally important species (e.g., grouse, ptarmigan) for First Nations and Nisga’a Nation (Rescan 2012). There were 55 species of migratory landbirds confirmed in the RSA during baseline studies.
	Raptors	x	x		x	Nests (year round) and certain raptors are protected under the BC <i>Wildlife Act</i> (Pahlke, McPherson, and Marshall 1996). Group includes culturally important raptors (e.g., bald eagle, golden eagle, northern goshawk) identified by the First Nations and Nisga’a Nation (Rescan 2012) and SARA-listed species (i.e., short-eared owl, confirmed to be present in the RSA). Identified as important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012) and CIS LRMP (BC ILMB 2000). Raptors and raptor nests have been confirmed in the RSA.
Amphibians	Western Toad		x		x	Western toad is a species of Special Concern under Schedule 1 of SARA (2002c). It has a confirmed presence in wetlands during baseline studies. This species has a priority rating of 2 for goal 2 in BC’s Conservation Framework, meaning that the Province is interested in preventive conservation to keep this species from becoming at risk.

\*AG = Aboriginal Group; G = Government; P/S = Public/Stakeholder; IM = Impact Matrix

**18.4.2 Assessment Boundaries for Wildlife and Wildlife Habitat**

Assessment boundaries define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with the receptor VCs, as well as the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries). The definition of these

assessment boundaries is an integral part of the assessment process of wildlife, and encompasses possible direct, indirect, and induced effects of the Project on wildlife, inclusive of Project effects on relevant intermediate components, as well as the trends in processes that may be relevant.

**Table 18.4-3. Wildlife Valued Components Excluded from the Application/EIS**

Wildlife Species Group	Proposed Valued Component	Identified by*				Rationale for Exclusion
		AG	G	P/S	IM	
Ungulates	Deer (Mule and White-tailed)	x			x	Deer are culturally important for First Nations and Nisga'a Nation, and hunted by local residents. Excluded because white-tailed deer and mule deer populations are secure and not at risk in BC and presence was not confirmed during baseline surveys.
	Caribou	x				First Nations and Nisga'a Nation identified caribou as culturally important. This species was excluded because the Project area is not within the generally acknowledged current caribou range. Some individuals may disperse into the area (evidenced by a shed antler found near the mine site area). However, no caribou were observed during aerial surveys for mountain goat or moose. This area may be part of the historical caribou range, but caribou in this area have since been functionally extirpated (BC MWLAP 2004c).
	Stone's sheep	x				Stone's sheep are culturally important for First Nations. Excluded because, while incidental presence of individuals may occur, they are not a regularly occurring species in the RSA.
Carnivores	Wolverine	x	x	x	x	Wolverine are blue-listed in BC and of Special Concern by COSEWIC (May 2003), and are a culturally important species for First Nations and Nisga'a Nation. Also identified in the Nass South SRMP (BC MFLNRO 2012) as requiring enhanced management consideration. Excluded because wolverine are habitat generalists and wolverine's low population density and large home-range size mean there would be limited interaction with the proposed Project. Wolverine habitat use and potential effects of the Project on wolverine are considered to be accounted for in the effects assessment by relying on models of grizzly bear and marten habitat. Potential Project effects are reflected in American marten and bear assessments. Mitigation and Monitoring also directly addresses potential effects on wolverine (Section 29.21), as it is recognized that not all effects on grizzly bears and American marten transfer directly to wolverine.
	Fisher	x		x	x	Fisher are provincially blue-listed, and are a culturally important species trapped by First Nations and Nisga'a Nation. Identified as an important species requiring increased management consideration by land management plans including the Nass South SRMP (BC MFLNRO 2012) and Cassiar Iskut-Stikine LRMP (BC ILMB 2000). Fisher are excluded as a VC, because their habitat use and potential effects of the Project are reflected in the American marten and black bear effects assessments and mitigation for black bears (e.g., avoiding den sites).
Carnivores	Lynx	x				These carnivore species were identified as culturally important (lynx, fox, wolf, coyote, weasel, ermine, mink, river otter) for First Nations and Nisga'a Nation. Lynx, fox, coyote and weasels were excluded because their populations are considered stable and not at risk, have low population density, and are able to adapt to and tolerate human disturbance well. Moreover, their populations are largely determined by prey availability. Because prey species (small mammals) and habitat requirements for this group (i.e., forest habitat) are similar to prey and habitat requirements of American marten, the potential Project effects on these species would be captured by the marten effects assessment. Wolf were excluded because the potential Project effects on wolves could be evaluated by examining their main source of prey (e.g., moose), which will be evaluated by the moose effects assessment.
	Fox	x				
	Wolf	x				
	Coyote	x				
	Weasel	x				
	Ermine	x				
	Mink	x				
	River otter	x				

(continued)

**Table 18.4-3. Wildlife Valued Components Excluded from the Application/EIS (completed)**

Wildlife Species Group	Proposed Valued Component	Identified by*				Rationale for Exclusion
		AG	G	P/S	IM	
Rodents Rabbits, and Hares	Beaver	x				Rodent species (beaver, rabbit, porcupine, snowshoe hare, red squirrel, flying squirrel, muskrat) were identified as culturally important for First Nations and Nisga'a Nation.  These species were excluded because all of the aforementioned populations are considered stable and not at risk. Further, important habitats for some of these species, specifically beaver and muskrat dams and lodges, are protected under a separate permitting process under the <i>Wildlife Act</i> (Pahlke, McPherson, and Marshall 1996). Other potential effects of the Project on beaver and muskrat would be captured by analyses of changes in wetland habitat within the waterbird assessment.
	Squirrels (red and flying)	x				
	Muskrat	x				
	Gophers	x				
	Porcupine	x				
	Snowshoe Hare	x				
Birds	Northern Goshawk	x	x			Potential Project effects reflected by raptor assessment. Northern goshawk habitat loss is assessed in the raptor assessment.
	Grouse	x				Potential Project effects reflected by landbird assessment because they use similar habitats.
	Ptarmigan	x				Potential Project effects reflected by waterbird assessment because they use similar habitats.
	Trumpeter Swan	x	x			Trumpeter swans are a yellow-listed species in BC. They have been highlighted by the CWS as a species requiring increased consideration, and species of interest for First Nations and by the CIS LRMP (BC ILMB 2000). Ten observations of trumpeter swan were made during staging surveys and seven observations were made during the spring pair and brood surveys, the majority of which were near Border Lake in the RSA, outside of the LSA. No breeding was confirmed in the LSA. Potential Project effects will be reflected by the waterbird effects assessment.
Amphibians	Wood Frog, Columbia Spotted Frog, Coastal Tailed Frog	x	x			Wood frogs and Columbia spotted frogs were excluded from the effects assessment because any potential effects on the species would be addressed in the assessment of alteration to wetland extent in the wetlands section (Section 15) and the western toad effects assessment. Coastal tailed frogs (SARA Special Concern, Schedule 1) were excluded from the effects assessment because the Project is located outside (to the north) of the known range of coastal tailed frogs.

\*AG = Aboriginal Group; G = Government; P/S = Public/Stakeholder; IM = Impact Matrix

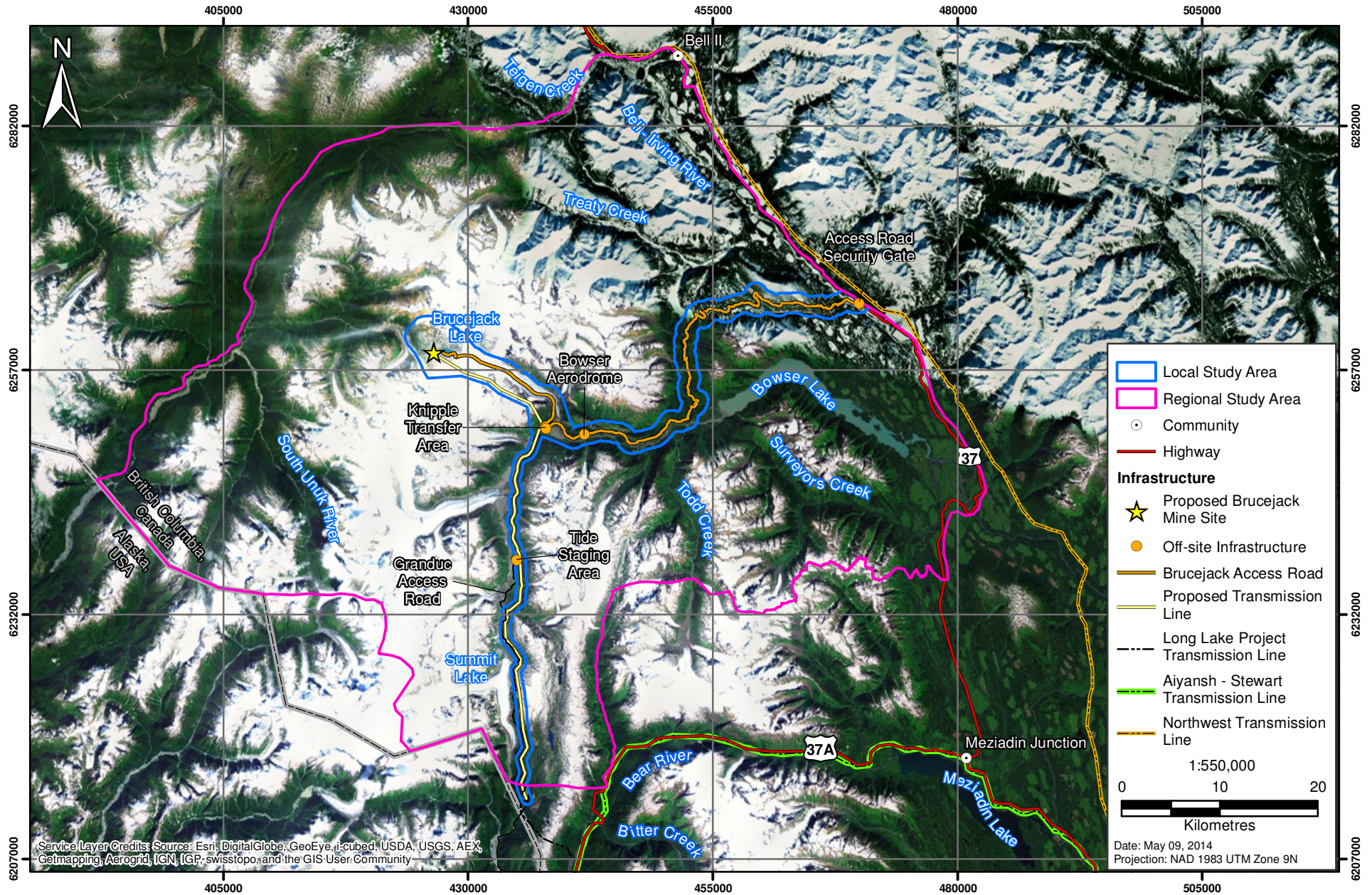
**18.4.2.1 Spatial Boundaries**

The wildlife and wildlife habitat effects assessment considered two study areas; an effects assessment LSA and RSA (Figure 18.4-1). The effects assessment LSA and RSA differ from the baseline LSA and RSA. The baseline study areas were defined prior to detailed infrastructure design; therefore, boundaries were designed to ensure extensive baseline surveys were conducted near all potential Project infrastructure. The LSA and RSA boundaries were refined for the effects assessment to account for the final Project design and focus the assessment to the areas potentially affected.

Local Study Area

The wildlife effects assessment LSA is 20,669 ha in extent and is defined by a buffer extending at least to the height of land or a 1-km buffer around the outer limits of the proposed infrastructure and 500 m from linear developments such as the access road and the transmission line (Figure 18.4-1). The LSA boundary around the mine site area extends to the height of land, or other natural barriers on the landscape.

**Figure 18.4-1**  
**Regional Study Area and Local Study Area for Wildlife Effects Assessment**



The Mine Site assessment area is 5,040 ha in extent and is situated above the treeline in alpine and parkland ecosystems. The Project assessment footprint encompasses the mine site assessment area, the transmission line (including a 40-m buffer along the line), and a 50-m buffer around the Knipple Transfer Area, Bowser Aerodrome, Tide Staging Area, and the hill to be removed near the aerodrome.

#### Regional Study Area

The RSA used for the effects assessment is slightly smaller than the RSA used for the baseline studies. The southern boundary of the RSA near the transmission line was shifted north for the effects assessment (Figure 18.4-1). This change was implemented to ensure the wildlife RSA completely encompassed the available Predictive Ecosystem Mapping (PEM), as the PEM is used to assess the effects of habitat loss and sensory disturbance on wildlife. The RSA used for the effects assessment is 368,146 ha (compared to 374,433 ha used for the Baseline Studies, see Section 18.3.3.3). Design of the RSA took into account the area that provides habitat for wildlife species that may come into contact with proposed Project infrastructure during the course of a season or a lifetime. Other ecological factors, such as height of land, were also considered when delineating boundaries. Section 18.3.3.3 provides further details regarding the selected boundaries of the RSA.

#### *18.4.2.2 Temporal Boundaries*

The assessment considered four Project phases:

- **Construction:** 2 years;
- **Operation:** 22 years;
- **Closure:** 2 years (includes Project decommissioning, abandonment, and reclamation activities); and
- **Post-closure:** minimum of 3 years (includes ongoing reclamation activities and post-closure monitoring).

The effects on wildlife during the Closure and Post-closure phases of the Project are assessed together for the wildlife assessment.

#### **18.4.3 Identifying Potential Effects on Wildlife**

Potential effects on wildlife and wildlife habitat by the Project have been raised during working group meetings by Aboriginal groups and government, and have been identified through best management practices, scientific literature, and technical expertise/professional judgment (Table 18.4-4). How and when these potential effects may arise due to the Project is summarized in Sections 18.4.3.1 to 18.4.3.4. A detailed description of the potential effects is provided in Section 18.5. Each issue is addressed for the wildlife VCs deemed to be of concern in Section 18.6. Ultimately, the effects are evaluated for their potential to alter survival and reproduction of VC species, and therefore, of the population within the effects assessment boundaries.

From the scoping assessment, seven potential effects were identified. These potential effects included habitat loss and alteration, sensory disturbance, disruption of movement patterns, direct mortality, indirect mortality, attractants, and chemical hazards. Each of these potential effects, including proposed mitigation and residual effects, is discussed in further detail in Section 18.5 and 18.6.

Table 18.4-4. Wildlife Effects Identified during Scoping

Effects	Identified by*				
	AG	G	P/S	O	AIR
Habitat Loss and Alteration	X			X	x
Sensory Disturbance	X			X	X
Disruption of Movement				X	
Direct Mortality	X	X		X	X
Indirect Mortality (Access)	X	X		X	X
Attractants	X			X	
Chemical Hazards (Health Effects)	X	X		X	X

\*AG = Aboriginal Group (Nisga'a Nation and First Nations comments, including traditional knowledge); G = Government (including legislation); P/S = Public/stakeholder comments; O = other (SRMP, LRMP, best management practices, professional judgment); AIR = Application Information Requirements.

#### 18.4.3.1 Construction

During Construction, any potential effects would occur in association with construction of Project infrastructure within the mine site and transmission line areas. Potential Project-related effects during Construction that were assessed in the wildlife and wildlife habitat effects assessment include:

- **Habitat Loss and Alteration:** potential adverse effect on wildlife species and populations caused by the direct removal or alteration of wildlife habitat. This effect would occur in association with the clearing of the Project footprint and would include any potential effects on wildlife from vegetation clearing for construction of infrastructure within the Project footprint.
- **Sensory Disturbance:** sensory disturbance to wildlife could occur from any disturbance—noise or visual—with the potential to adversely affect an animal, most commonly through a behavioural, endocrine (acute or chronic stress reaction), or energetic response.
- **Disruption of Movement:** adverse effect on wildlife movement from direct means such as wildlife movement barriers (e.g., the mine site) or corridors (e.g., access roads or transmission line) and indirect means such as traffic disturbance causing habitat fragmentation and edge effects.
- **Direct Mortality:** potential effects of wildlife mortality caused by vegetation clearing, construction machinery, and vehicle traffic.
- **Indirect Mortality:** potential effects on wildlife from mortality caused by increased access and hunting pressure.
- **Attractants:** wildlife may be attracted to the Project area by attractants such as food wastes and other anthropogenic attractants from construction crews and camps.
- **Chemical Hazards:** some wildlife may uptake chemicals (e.g. organic anthropogenic substances, metals, etc.) from construction camps, from ingestion of dust on soil or vegetation, or via bioaccumulation from prey.

#### 18.4.3.2 Operation

During Operation, potential effects for wildlife and wildlife habitat are:

- **Habitat Loss and Alteration:** some habitat loss and alteration may occur if the project expands in area.

- **Sensory Disturbance:** potential effect on wildlife and wildlife habitat resulting from avoidance caused by noise from operation machinery, vehicles, helicopters, blasts, processing plant, and human activity, as well as avoidance of or attraction to artificial lighting of the facilities, roads, and Brucejack Mine Site.
- **Disruption of Movement:** wildlife movement may be impacted indirectly due to habitat fragmentation and edge effects or avoidance of movement corridors due to disturbance, or due to direct means, such as by creating physical movement barriers or corridors.
- **Direct Mortality:** potential effects of direct wildlife mortality due to vehicle traffic or bird mortality caused by transmission line electrocution or collision.
- **Indirect Mortality:** potential effects on wildlife from mortality caused by increased access and hunting pressure, or range shifts leading to competition for resources.
- **Attractants:** wildlife attracted to the Project area by odours of food wastes or other anthropogenic attractants from crews and camps.
- **Chemical Hazards:** wildlife may uptake chemicals from camps or industrial sites, water in Brucejack Lake or receiving environments, from ingestion of dust on vegetation or soil, or via bioaccumulation of prey species.

#### 18.4.3.3 Closure and Post-closure

The assessment for the Closure phase of the Project will be the same as Post-closure; therefore, the effects scoping summary for Closure also applied to the Post-closure phase and the two phases are presented together throughout the effects assessment (see Section 18.4.3.4 below). Eventually all Project infrastructure will be removed and where feasible, areas will be re-vegetated.

During Closure and Post-closure, project-related effects during Closure and Post-closure assessed within the wildlife and wildlife habitat effects assessment include:

- **Indirect Mortality:** potential effects on wildlife from mortality caused by increased access and hunting pressure when activity in the area has ceased; however, the Brucejack Access Road and Brucejack Transmission Line right-of-way (ROW) will both be decommissioned and re-vegetated at Closure when they are no longer required, minimizing this effect.
- **Chemical Hazards:** wildlife may uptake chemicals during and after decommissioning the camp or industrial sites, water in Brucejack Lake or receiving environments, from ingestion of dust settled and remaining on, or taken up into vegetation or soil during the Closure and Post-closure phases, or via bioaccumulation through prey species.

## 18.5 EFFECTS ASSESSMENT AND MITIGATION FOR WILDLIFE

Given the hierarchical nature of biological systems, potential wildlife effects are discussed at two levels: the individual animal level (e.g., behaviour, physiological condition, and survival) and the population level (population size, distribution, mortality rate, reproductive fitness) as necessary for the effect being assessed. A population is defined as “a group of organisms coexisting at the same time and place and capable of interbreeding” or “as a group of non-specific organisms that occupy a loosely defined geographic region and exhibit reproductive continuity from generation to generation” (Futuyma 1979). Because the geographic population boundaries for local populations considered in this assessment are unknown and dynamic, some portions of the assessment are qualitative. The assessment primarily focuses on potential effects on local populations within the RSA.

The assessment considers the statutory requirements and policy statements which influence wildlife management. These include provincial and federal legislation, policies, and best management practice guidelines applicable to wildlife and wildlife habitat in BC. The assessment also considers wildlife objectives and management direction outlined in relevant LRMPs, SRMPs, and wildlife policy documents.

The wildlife and wildlife habitat effects assessment was prepared according to applicable best management guidelines and the *Environmental Assessment Best Practice Guideline for Wildlife at Risk in Canada* (Environment Canada 2004), and in accordance with Section 9.7 of the AIR (BC EAO 2014). The assessment is based on current available knowledge of species behaviour, presence, distribution, population biology, and ecology. Consideration is also given to linkages between potential effects from the proposed development that occur on both the individual (e.g., an animal's response to noise) and local population level (e.g., population change due to altered habitat), where applicable.

From the scoping assessment, seven potential effects were identified: habitat loss and alteration, sensory disturbance, disruption of movement patterns, direct mortality, indirect mortality, attractants, and chemical hazards. Each of these potential effects, including proposed mitigation, is discussed in further detail in the following sections.

### 18.5.1 Habitat Loss and Alteration

Habitat will be lost or altered within the Project footprint during Construction and Operation. The amount of habitat affected for each of the ten VCs was calculated by overlaying the assessment footprint that incorporates the mine site assessment area, the transmission line including a 40-m buffer along the line, and a 50-m buffer around the Knipple Transfer Area, Bowser Aerodrome, Tide Staging Area, and the hill to be removed near the aerodrome on the Habitat suitability modelling and/or vegetation mapping, and the results of baseline characterization studies for each wildlife VC. The results of these analyses are described in Section 18.6.

The wildlife RSA is located in an area with old-growth forests, wetlands, riparian forests, and alpine terrain, which provides habitat to a diverse wildlife community. The Project will result in the loss or alteration of varying amounts of all habitat types. Various Project components including, but not limited to, roads, transmission line, camps, and the aerodrome contribute to the overall habitat loss and alteration.

Habitat is defined as the suite of resources (e.g., food and shelter) and environmental conditions (both abiotic and biotic) that determine the presence, survival, and reproduction of a population. Habitat quality can be rated by the suitability of the habitat to provide important life requisites, namely feeding and shelter. Habitat suitability models were created during baseline studies for five wildlife VCs using standard provincial methods (RISC), and ground-truthed against survey data ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

Direct habitat loss and alteration was calculated using habitat suitability models developed for the following five VCs:

- moose (early winter and late winter);
- mountain goat (winter and summer);
- grizzly bear (spring, summer, fall, denning);
- American marten (winter); and
- hoary marmot (growing season: spring, summer, and fall combined).

Habitat suitability mapping was not undertaken for bats, raptors, waterbirds, landbirds, or western toads. Habitat loss and alteration assessments for these species were evaluated from habitat features surveyed in the field and identified from vegetation mapping (Chapter 16, Assessment of Potential Territorial Ecology Effects).

The habitat loss and alteration assessment was based on the Project footprint and/or the mine site assessment area (Section 18.4.2). The mine site assessment area is the buffered area around the planned mine site (Figure 18.4-1). Project components included in the habitat loss calculations include the mine site assessment area, the transmission line (including a 40-m buffer along the line), and a 50-m buffer around the Knipple Transfer Area, Bowser Aerodrome, Tide Staging Area, and the hill to be removed near the Aerodrome.

The amount of suitable habitat that will be lost or altered due to the Project was calculated by overlaying the Project assessment footprint on habitat suitability maps developed using HSRs for each of the assessed species. The habitat assessment considers habitat loss as areas permanently lost (direct loss due to the footprint) and fragmented (habitat surrounded on three or more sides by development or infrastructure). The habitat rankings for the areas associated with the species-specific habitat models provided the basis for discussion of the availability and quality of habitat to be lost or altered as a result of the proposed Project. In addition to habitat suitability and vegetation analysis, important wildlife habitat or features (e.g., salt licks) identified through baseline studies, land and resource management plans, existing inventories, academic studies, and TK/TU studies were considered when assessing potential effects of habitat loss and alteration on wildlife VCs.

Direct habitat loss and alteration will begin during the Construction phase of the Project and the extent of loss will be at its majority at the end of Construction/beginning of Operation. Some additional habitat loss may be incremental and occur throughout Operation, although this is not anticipated. The discussion of habitat loss and figures presented focus on the total amounts lost and altered at the start of the Operation phase, as this will represent the largest extent of the Project footprint. Wherever possible, reclamation activities will be undertaken to restore habitat following Closure. The areas to be reclaimed and reclamation plans are described in Chapter 30, Closure and Reclamation.

#### *18.5.1.1 Mitigation for Habitat Loss and Alteration*

Mitigation for direct habitat loss and alteration varies with each VC species. Project mitigation for habitat will include, but is not limited to:

- avoidance of important habitat where practicable alternatives are available (e.g., habitat loss and alteration was minimized through Project design changes in the Brucejack Transmission Line ROW by placing the towers at high elevation where tree felling is not required); and
- re-vegetation/reclamation of some components during Closure.

Detailed information regarding mitigation and management of habitat loss and alteration for wildlife VCs is described in Section 29.21, Wildlife Management and Monitoring Plan.

#### **18.5.2 Sensory Disturbance**

Sensory disturbance from Project-related light or noise and human presence may alter the behaviours of wildlife species, resulting in behavioural changes or habitat avoidance. Hence, sensory disturbance can be considered functional habitat loss for wildlife VCs. This section discusses the potential effects of sensory disturbance on the various wildlife VCs in the Project area.

### 18.5.2.1 Light

Artificial lighting can have adverse effects for migratory birds when combined with high towers or buildings (Trapp 1998; FLAP 2010). Migratory birds can become disoriented by lighted towers, and mortality events may result (T. Longcore and Rich 2004). Artificial light can also cause nest abandonment and subsequent higher predation rates (Hockin et al. 1992). All of these disturbance types can reduce reproduction rates and local population size.

Bats and owls may also be attracted to the abundance of prey (insects and small mammals) associated with artificial lighting, or *Myotis* species may avoid bright lights as a predator avoidance strategy (Bat Conservation Trust 2008). The potential effect of lights on bats and owls can be minimized by modifying light design and use. For example, using low-pressure sodium lamps, or fitting lamps with ultraviolet filters can reduce the effect on bats. Similarly, limiting times during which lighting is used and using directional lighting can also limit the effects on bats (Fure 2006).

### 18.5.2.2 Noise

Noise affects wildlife species in three primary ways. The source, duration, and intensity of noise all influence the nature and magnitude of observed effects and determine if wildlife exhibit an acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). First, an acute effect of noise—brief, intense, localized noise (such as blasting)—can result in physiological damage to an animal’s ears or flight from adjacent habitats.

Second, and likely the most common response, is a behavioural response, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997), reduced reproductive success, and/or mortality of offspring and parent—a chronic effect. A behavioural response can also occur when animals avoid high-quality habitats near disturbance sources resulting in the functional loss of that habitat (D. H. Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). The disturbance may cause animals to abandon their current range. These range shifts can result in mortality due to unfamiliarity with new habitat. Noise can also mask the sounds that animals use to find prey, mates, and avoid predators. Masking can reduce fitness (breeding success), especially for species that are highly reliant on their acoustic environment.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment.

Effects of noise on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Different animals are sensitive to different frequency ranges; bats are sensitive to ultrasound (above 20 kilohertz) frequencies, whereas some birds (Kreithen and Quine 1979), amphibians (Hetherington 1992), and large mammals are sensitive to infrasound (below 20 hertz).

Some species have been found to respond to specific levels of noise above background noise, termed a “threshold level.” For example, grizzly bears are reported to avoid areas (78 to 80% of the time) with noise levels greater than 60 dBC (Archibald, Ellis, and Hamilton 1987). Ungulates respond to aircraft overflights and sonic booms at noise levels between 85 and 108 dB Lpeak (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Bird densities have been found to decrease within 1 km of infrastructure areas (Benitez-Lopez, Alkemade, and Verweij 2010), and a series of studies on birds in grasslands reported that the abundance and diversity of birds began to drop when

noise levels reached  $47 \pm 3.5$  dBA near roads (baseline  $38 \pm 5$  dBA; Reijnen and Foppen 1994, 1995; Reijnen, Foppen, and Meeuwsen 1996).

During Construction, potential sources of continuous Project noise include vegetation clearing and infrastructure construction. Instantaneous/short duration noises include blasting, vehicle traffic, and helicopter/aircraft overflights. During Operation, potential sources of Project noise include industrial day-to-day operation, while instantaneous noise includes helicopter/aircraft overflights, blasting, and vehicle traffic along the roads.

#### 18.5.2.3 Methodology for Assessing Effects of Sensory Disturbance on Wildlife

Many sources of sensory disturbance have overlapping disturbance effects. For example, an increase in traffic volume along roads is a source of noise and visual disturbance. These effects are often studied separately in scientific literature, but will occur together at the Project site. For this assessment, it is assumed that noise levels travel farther than visual disturbances; therefore, the assessment of sensory disturbance is based on the effects of increased noise from Project development.

For the sensory disturbance assessment, the area outside of the Project footprint and assessment area that would be affected by noise was evaluated as functionally lost habitat. The effects of noise on wildlife was assessed using noise models (Chapter 8, Noise Predictive Study), which produced a map of sound emanating from sources. For a point source noise, the noise modelling resembles a topographic map with decreasing sound contours with increasing distance. The area of wildlife habitat affected was calculated by choosing specific noise level contours from the modelling. Four types of noise were chosen for the Construction and Operation phases: 1) Project noise (45 dBA Ln); 2) helicopter and aircraft overflights (80 dBA LAE); 3) traffic noise (75 dBA LAE); and 4) blasting noise (108 dB Lpeak and 120 dB Lpeak). Chapter 8, Noise Predictive Study, provides a description and definitions of the various types of noise.

General Project-related noise levels from continuous sources are presented as “A-weighted” decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on chronic noise threshold values identified for birds (47 dBA; Reijnen and Foppen 1994, 1995; Reijnen, Foppen, and Meeuwsen 1996). In addition, the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat. Traffic noise was included in Project noise models (45 dBA Ln) averaged over the 12-hour period and evaluated as a continuous noise, which accounts for a minimal amount of disturbance. Traffic was also assessed as an instantaneous noise using a threshold of 75 dBA LAE to ensure the full extent of traffic disturbance was considered.

Helicopter and aircraft noise were evaluated as a short duration noise using a noise level threshold of 80 dBA LAE based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymsen and Suter 2001). This threshold level was also selected based on mountain goat sensitivity to helicopter overflights (Côté 1996; BC MOE 2010b), rock-breaking noises (Bears, Mak, and Spicker 2012), and ungulate response to noise (Luz and Smith 1976; Mancini et al. 1988).

Two values were chosen for the instantaneous blasting noise assessment: 1) a value where wildlife are expected to avoid habitat (“functional habitat loss”; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally (“disturbed habitat”; 108 dB Lpeak). The blasting noise level threshold of 108 dB (Lpeak) represents “disturbed habitat” and was selected based on a

range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). The threshold of 120 dB was selected to represent “functional habitat loss,” and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Ontario Ministry of Environment 1977; Environment Canada 2010). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB ( $L_{peak}$ ) or higher for instantaneous noise effects. The peak levels ( $L_{peak}$ ) are presented for the instantaneous blasting noise, which is the maximum exposure due to blasting in the underground works.

#### 18.5.2.4 Mitigation for Sensory Disturbance

The effects of sensory disturbance on wildlife are considered by mitigating effects of light (e.g., infrastructure design) and noise (Section 29.11, Noise Management Plan). Guidelines will be followed to minimize the effects on wildlife (Milko 1998a; BC MOE 2006b).

##### Light

The mine facilities are likely to be lit continuously during night-time for worker safety considerations. This increases the potential for effects on wildlife. These effects will be mitigated by using directed/focused lighting rather than broad area lighting and by shielding lights to minimize stray light. Lighting in non-essential areas will be used only when necessary, without compromising safety of employees.

##### Noise

During Construction and Operation, wildlife may be disturbed by traffic noise and mine operation noise (e.g., blasting, haul trucks, aircraft, and processing plant). A noise management plan will be developed with the objective to ensure that noise levels during all phases of the Project are acceptably low for human and wildlife receptors, as per human health guidelines (Health Canada 2011). The following noise mitigation measures will be implemented:

- noise specifications will be considered when selecting equipment to purchase;
- vehicles will be maintained regularly;
- speed limits will be imposed;
- mufflers will be installed on vehicles and maintained;
- noise dampening measures will be applied where possible;
- pre-determined flight paths will be used by helicopters and fixed wing aircraft, that will have a vertical buffer distances of at least 300 m, where possible, from sensitive habitats and known areas of wildlife use;
- pilot education regarding the negative effects of over-flights on wildlife species and the importance of maintaining a minimum prescribed altitude when possible above wildlife species and identified sensitive habitat areas; and

#### 18.5.3 Disruption of Movement

Disruption of wildlife movement was identified as a potential effect where the Project footprint and associated infrastructure may interrupt animal movements. Movement between patches of habitat is important to maintain wildlife populations and biodiversity (Bennett 2003). Disruption of movement patterns is often the result of increased habitat fragmentation (e.g., increased density of human access corridors such as roads, and increased cleared areas) or higher road use levels limiting daily or seasonal wildlife travel. Various Project components may contribute to the overall disruption of movement,

including roads and mine infrastructure. This section outlines the potential effects of Project development on wildlife movement.

Wildlife movement corridors provide a linkage between daily or seasonal habitats. Disruption of movement can occur through fragmentation of habitat (e.g., a road may separate two blocks of forest habitat) and through blockage of topographically restricted movement corridors (e.g., infrastructure or roads restrict movement through a narrow valley or trail that connects two distinct habitats). Baseline studies (e.g., collaring) were not conducted to specifically identify movement corridors. Instead, likely movement corridors were identified during baseline studies from expert opinion of field biologists in the following ways:

- For larger animals such as moose and bears, knowledge of their typical movement patterns were used to identify topographic features such as valleys, saddles, and wetlands where the movements of these animals is likely focused. These areas were then discussed in the effects assessment.
- For smaller animals, such as furbearers, Project features that are located in suitable habitat identified from vegetation mapping and habitat suitability mapping were evaluated as potential barriers to movement (e.g., roads through old growth forest).

Roads may act as a barrier to movement for some wildlife species. By preventing movement, habitat barriers can have population-level effects (Fahrig and Rytwinski 2009). The width, substrate, and volume of vehicle traffic along a road will likely affect species differently. In general, large roads with relatively high traffic volume have the greatest effect on wildlife crossing, while roads with lower volumes may be crossed or used as travel pathways.

Increased traffic volumes along the access road may decrease the crossing by certain species. Vehicles will be used during the Construction, Operation, and Closure phases 365 days a year and 24 hours per day. The numbers of vehicles on the road per day, and per hour, are summarized in Table 18.5-1. Only Project traffic is evaluated in this section of the Application/EIS.

**Table 18.5-1. Access Road Vehicle Traffic (One-way Trips) during Operation Phase**

Project Phase	Number of Project Vehicles per Day and per Hour (Traffic 365 Days/Year and 24 Hours/Day)	
	#/day	#/h
Operation (Average)	86	3.58

Road-clearing activities that create high snowbanks in the winter may prevent certain species from crossing roads. High snowbanks can restrict the movement of ungulates across the road, thus creating a movement barrier. If an ungulate is successful in gaining access to the road, the animal may become trapped on the road by snowbanks, increasing the likelihood of mortality. Roads can also facilitate movement and act as travel routes for both prey animals and predators such as wolves, indirectly increasing predation on ungulate prey (J. Whittington, St Clair, and Mercer 2005; McKenzie et al. 2012).

Project infrastructure other than roads may also create a physical barrier to movement for wildlife, or may be avoided by wildlife due to disturbance. Sensory disturbance (Section 18.5.2) may result in wildlife avoiding the area, and as a result, creating a movement barrier to species such as bears and ungulates (Dyer et al. 2002; Vistness and Nellemann 2008).

Disruption of movement is evaluated as beginning during the Construction phase of the Project and continuing through the Operation and Closure phases.

### 18.5.3.1 Mitigation for Disruption of Movement

A number of mitigation strategies will be used to reduce the disruption to wildlife movement. Strategies will include, but are not limited to:

- minimizing human activity in identified high-quality wildlife habitats and movement corridors;
- managing snowbank height on Project roads and creating escape pathways (i.e., gaps) in snowbanks to allow wildlife (e.g., moose) to exit the road area;
- creating and maintaining road culverts to facilitate wildlife movement/habitat connectivity;
- incorporating wildlife passages into road and bridge design over river and creek crossings to allow wildlife to move underneath;
- applying reduced speed limit restrictions on traffic along parts of the Brucejack Access Road that bisect potential movement corridors;
- educating employees to assess and adaptively manage driving activities during crepuscular hours (i.e., dawn and dusk), which are periods of high wildlife activity;
- bussing staff to the Brucejack Mine Site, where possible, to limit traffic disturbance over the course of a day; and
- reclamation activities will be undertaken and designed to remove barrier and accommodate movement following mine closure.

A description of mitigation and management to address disruption of movement to wildlife VCs is presented in Section 29.21, Wildlife Management and Monitoring Plan.

### 18.5.4 Direct Mortality

Direct mortality of wildlife could occur during the following activities (Table 18.5-2):

- vehicle-wildlife collisions;
- vegetation clearing during infrastructure construction;
- avalanche control; and
- bird interactions with the Brucejack Transmission Line.

**Table 18.5-2. Potential Effects that May Cause Direct Mortality to Wildlife Valued Components**

Wildlife Valued Component	Potential Effects that May Cause Direct Mortality			
	Vehicle-Wildlife Collisions	Vegetation Clearing	Avalanche Control	Transmission Line
Moose	X			
Mountain goats	X		X	
Grizzly bears	X			
American marten	X	X		
Hoary marmots	X	X		
Bats		X		
Waterbirds	X	X		X
Raptors	X	X		X
Landbirds	X	X		
Western toads	X	X		

### *Vehicle-Wildlife Collisions*

The Project Effects Assessment evaluated vehicle-wildlife collisions on the Project access roads. Vehicle-wildlife collision data for highways in BC was used to estimate the effect of direct mortality along the Project access roads, where possible.

Records of mortalities of several wildlife species along BC highways are kept by the Province of BC (McElhanney 2011; Sielecki 2004). This information is compiled in the Wildlife Accident Reporting System (WARS) database, which is maintained by the British Columbia Ministry of Transportation and Infrastructure. There are several limitations to the WARS data, including under-representation of wildlife mortalities and lack of information regarding locations of accidents. For example, in 2002, of 5,031 reports received, 28% lacked valid segment numbers, and 28% lacked valid kilometre references (Sielecki 2010). Therefore, although WARS data are the best available information, they must be interpreted with caution.

Within the Bulkley-Stikine District (which includes Highway 37, which is immediately east of the RSA), the WARS database is subdivided into highway Landmark Kilometre Inventory (LKI) segments. The portion of Highway 37 parallel and to the east of the RSA is included in LKI segment 3730; therefore, data from this segment are used in this assessment to estimate numbers of vehicle-wildlife collisions that may occur along the access road.

Vehicle-wildlife collisions are cited as a significant cause of direct mortality for a variety of wildlife species, in some cases with population-scale consequences (Vieira 1999; Kerley et al. 2002; Deem and Emmons 2005). Collisions between large animals and vehicles can also have implications for human safety. Many wildlife species in BC are more susceptible to vehicle collisions during certain times of the day and year; for instance most vehicle-moose collisions occur during winter. Some species are more active at dawn and dusk (crepuscular), while others are more active at night (nocturnal). Most casualties occur near water sources where shrub and vegetation cover is greater, at curves in the road, and during seasons corresponding to highest animal activity (i.e., breeding and dispersing; Drews 1995; Romin and Bissonette 1996; Main and Allen 2002; Nielsen, Anderson, and Grund 2003; E. Lee et al. 2004; Saeki and MacDonald 2004; Guter et al. 2005; Hell et al. 2005). Wildlife may also be attracted to roads due to de-icing salts, attractive roadside vegetation, and as a travel corridor, further increasing the likelihood of vehicle-wildlife interactions. In some cases, animals can become trapped on ploughed roads where high snowbanks prevent exit from the road surface.

The proposed Project could contribute to interactions with wildlife along the access road. During Operation, Project-related vehicle traffic will average 86 one-way trips/vehicles per day along the Brucejack Access Road; therefore, potential vehicle interactions with wildlife could occur.

### *Vegetation Clearing*

During Construction, some wildlife species such as American marten, hoary marmots, bats, birds, and western toads may be susceptible to direct mortality caused by vegetation clearing. Removal of mature trees that support dens may cause mortality to these species during the denning period (generally between October and April). Clearing trees or vegetation that support active bird nests during construction could also cause direct mortality of bird species. Bird nests are sensitive elements protected under the *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) and *Migratory Birds Convention Act* (1994). Clearing riparian vegetation and moving large construction machinery near or within riparian areas could cause direct mortalities of western toads/toadlets and other amphibians.

*Avalanche Control*

During the winter, mountain goats occupy habitat in or near areas prone to avalanche. Natural avalanches may result in direct mortality to mountain goats, although this is relatively uncommon (BC MOE 2010b). Avalanche control measures along the access roads and at the Brucejack Mine Site will increase the frequency of avalanches and may put goats at a higher risk of avalanche-associated mortality.

*Transmission Line*

Transmission lines may cause direct mortality of birds through electrocutions and in some cases collisions (Savereno et al. 1996; Bevanger 1998; Ledger and Hobbs 1999). Birds with larger wingspans, such as raptors and swans, are most vulnerable to collisions because they are less manoeuvrable (APLIC 2006). Collisions are recognized as a cause of waterfowl mortality (Manitoba Hydro 1995) with many species of ducks vulnerable due to their high flight speed, wing loading, and their behaviour of travelling in flocks (Sundararajan and Gorur 2005). This may occur when transmission lines are located near wetlands, lakes, and other habitats where birds congregate in winter, when breeding, or migrating.

**18.5.4.1 Mitigation for Direct Mortality**

Direct mortality will be mitigated through the following measures:

- communicating locations of wildlife observed along roads;
- yielding to wildlife observed along roads;
- making appropriate provisions along Project roads to facilitate wildlife (e.g., toad) movement without risk of collisions;
- creating breaks in snowbanks along ploughed Project roads, particularly at bends;
- providing signage along Project roads in high-value wildlife areas or known wildlife travel corridors to warn vehicle operators of the potential to encounter wildlife;
- designing and placing transmission structures to minimize strikes and electrocutions, following guidelines for bird protection (APLIC 2006);
- cutting vegetation low at wildlife crossings along roads to ensure visibility of animals; and
- scheduling vegetation clearing activities outside of sensitive periods (e.g., breeding from April 1 to July 31 for general breeding birds), where feasible, and conducting pre-clearing surveys before vegetation is removed during the nesting season.

**18.5.5 Indirect Mortality**

The primary source of indirect mortality identified for wildlife VCs in association with Project development is increased hunting pressure on ungulates and bears—both legal and illegal—as a result of greater human access to the RSA.

Considerable research over the past 30 years has shown that the primary effect of new linear features (e.g., roads, transmission line right of ways) on wildlife has been to increase access for recreation users and hunters (Andrews 1990; Gates 1992; Nellemann et al. 2003; Reed 2004). These effects are largest when a new road or other linear feature provides access to an otherwise inaccessible area. The primary effect of increased access is increased hunting (Laurian et al. 2008).

Existing access roads occur along the Bell-Irving River and west of Highway 37 in the southeast of the RSA, where there are 62.76 m of road/km<sup>2</sup>. With development of the Project, the Brucejack Access

Road will create new access. Construction of the transmission line will use the existing the Granduc Access road. These corridors are assessed for their potential to increase access to high-quality moose, mountain goat, and bear habitat and thereby indirect mortality.

Hunting is regulated by the BC MFLNRO. However, local population declines from hunting could occur in circumstances where new access is created, including:

- in high-quality habitat which functions as spatial refugia for wildlife (grizzly bears and mountain goats);
- in high-quality habitat areas where environmental conditions force animals into a confined space during the winter (moose); and
- where the proposed Project would result in new access for unregulated hunters to high-quality moose habitat (as this may result in an increase of the total numbers of moose removed—including females—which has a greater effect on the population).

#### 18.5.5.1 *Mitigation for Indirect Mortality*

The need for better access management is one of the key issues identified in the Nass South SRMP and the CIS LRMP. Specifically, the LRMP and SRMP both indicate strategies to minimize or avoid road construction in ungulate winter ranges (moose and mountain goat) and important grizzly bear habitat (e.g., avalanche chutes, high berry producing areas, and salmon spawning grounds).

Measures to avoid effects on ungulates and bears during Construction, Operation, and Closure will include restricting access to Project roads and only permitting traffic that is required for the Project. The Brucejack Access Road is gated to prohibit entry by non-authorized vehicles. Security measures to control access by snow machines, all-terrain vehicles (ATVs), and persons on foot are addressed by use of a manned gate. At Closure, all non-essential roads, including the Brucejack Access Road, will be deactivated and traffic will be greatly reduced.

#### 18.5.6 **Attractants**

Features or materials associated with a mining project that interest or provide resources to wildlife are considered to be wildlife attractants. The Project contains both features and materials that have the potential to attract wildlife. Project infrastructure and activities with the potential to attract wildlife include:

- odours and food sources associated with cooking, incinerators, garbage, or sewage;
- refuge, shelter, nesting, perching, or roosting habitat provided by Project structure;
- regenerating vegetation on road verges or other disturbed areas that creates desirable forage;
- travel corridors such as roads or cleared areas under transmission lines that facilitate movement through otherwise difficult terrain or vegetation; and
- ponds or ditches created by development that provide water and aquatic habitat.

Odour-causing attractants can potentially affect bears and American marten. Odours are particularly problematic for bears. The presence of odours poses indirect risks as they can draw animals to populated areas where they become habituated to people. Habituated wildlife can pose a threat to the safety of both humans and wildlife (i.e., attacks) and often necessitates wildlife relocation or destruction.

Structures (e.g., buildings, adits, towers) can act as attractants and can affect birds, furbearers, and bats. Animals that use Project infrastructure may be at risk of mortality since their presence can interfere with mechanical functions of equipment. Waterbirds may be attracted to Brucejack Lake, a tailing storage facility. Use of these facilities can have potential health effects for birds.

Regenerating vegetation on road verges or in other disturbed areas that creates desirable forage can affect a number of species, including ungulates and bears. Attracting animals to roads and areas of development can potentially lead to increased incidents of wildlife/vehicle collisions and other interactions that put animals and humans at risk.

Travel corridors (e.g., roads or cleared areas under transmission lines) that enable wildlife movement through difficult terrain or dense vegetation can have potential effects on species such as moose and bears. Wildlife travel corridors can provide energetic benefits to wildlife but they can also pose potential risks to animals that may experience increased vulnerability to human-mediated mortality sources such as collisions with vehicles.

Artificial ditches near roads can have a potential effect for western toads. Ephemeral pools that form in roadside ditches in spring can be attractive to western toads for breeding.

#### *18.5.6.1 Mitigation for Attractants*

Mitigation of attractants typically takes a two-tiered approach. First, positive behavioural stimuli are removed, such as limiting high-quality forage on road verges. Second, if wildlife are still attracted to the feature, then negative reinforcement is used to dissuade them from returning. A good example is garbage areas. It is easier and safer for staff and wildlife to remove the positive attractant of garbage than to attempt to repel wildlife once they have become habituated to this food source.

Mitigation strategies that are designed to reduce the effect of attractants on wildlife VCs will include, but are not limited to:

- managing waste to minimize attractants and rewards;
- planting less-attractive vegetation in roadside areas;
- avoiding use of salt, included in traction grit, for winter road management;
- monitoring and adaptive management of the use of physical structures by wildlife for security habitat (refuge, shelter), daily activities (roosting, perching), or nesting purposes; and
- avoiding the creation of roadside pools attractive to western toad.

Detailed information regarding mitigation and management of attractants to wildlife VCs is described in detail in Section 29.21, Wildlife Management and Monitoring Plan.

#### **18.5.7 Chemical Hazards**

Exposure to chemical hazards was identified as a potential effect for wildlife VCs (Sections 18.4.3). For the purposes of this assessment, a chemical hazard is defined as a chemical that has the potential to cause an adverse health effect on wildlife VCs due to Project activities during the Construction, Operation, Closure, or Post-closure phases. For the assessment of chemical hazards in wildlife, the mine site area was considered separately from the access road area, which includes the Brucejack Access Road, Knipple Transfer Area, and Bowser Aerodrome (Figure 18.5-1), as exposure to chemicals of potential concern (COPCs) and wildlife use of these two general areas are anticipated to be different. The Brucejack Transmission Line ROW was excluded from the wildlife chemical hazards assessment as it was not anticipated to result in any chemical hazards to wildlife.

18.5.7.1 Methodology for Assessing Effects of Chemical Hazards on Wildlife

In order to determine the potential effects of COPCs on wildlife VCs due to Project-related activities, the following four factors are necessary to consider for an effect and are described in the following sections:

- source of a COPC;
- presence of a wildlife VC receptor that can uptake the COPC;
- an exposure route for the COPC (method of uptake, e.g. ingestion); and
- duration of chemical exposure and COPC toxicity.

Four potential Project-related sources of COPCs were evaluated, including those:

1. associated with mine development and operation;
2. available in water;
3. associated with metal leaching / acid rock drainage (ML/ARD); and
4. associated with dust.

In addition to Project related sources of COPCs, bioaccumulation of persistent COPCs that are known to bioaccumulate up the food chain were evaluated in top predator species (e.g. grizzly bears) if they were scoped in as a result of the assessment of Project-related sources of COPCs in wildlife prey species.

Wildlife exposed to elevated concentrations of a COPC may be affected by these chemicals if they are taken up into their bodies from the environment and exceed effect thresholds. Rationale for inclusion and exclusion of individual COPCs and wildlife VCs to these chemical hazards is outlined in the following sections and summarized in Table 18.5-3.

**Table 18.5-3. Sources of Chemicals of Potential Concern Evaluated for Valued Components**

Valued Component	COPC Associated with Mine Development and Operation	COPC in Water	COPC Associated with ML/ARD	COPC in fugitive dust	Bioaccumulation of COPC in the Food Web
Moose	NA	NA	NA	NA	NA
Mountain goats	NA	Yes	NA	NA	NA
Grizzly bears	Yes	NA	NA	NA	Yes
American marten	Yes	NA	NA	NA	NA
Hoary marmots	NA	Yes	NA	NA	NA
Bats	NA	NA	NA	NA	NA
Raptors	NA	NA	NA	NA	NA
Wetland birds	NA	NA	NA	NA	NA
Landbirds	NA	NA	NA	NA	NA
Western toad	NA	NA	NA	NA	NA

NA = Not assessed.

### Screening of COPCs

The screening process for COPCs in water involved screening against two assessment criteria: applicable guidelines and baseline concentrations.

BC-specific wildlife, aquatic life, and livestock guidelines were preferentially used when available, and mean modelled concentrations of potentially COPC-containing environmental media were compared to the British Columbia's Water Quality Guidelines (BC MoE 2013c).

Where no BC-specific guidelines are available for wildlife, mean modelled concentrations were screened against CCME guidelines. The CCME has established the following environmental quality guidelines for different media:

- Water quality guidelines for the Protection of Aquatic Life - Freshwater (CCME 2012c);
- Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PELs) for the Protection of Aquatic Life. Freshwater (CCME 2012a); and
- Soil Quality Guidelines for Protection of Environmental and Human Health - Agricultural (CCME 2012b).

The potential for wildlife VCs to be exposed to COPCs from various Project-related sources is evaluated in the following sections. Predictive study results from the following intermediate components were used to support the effects assessment for chemical hazards for wildlife:

- Brucejack Gold Mine Project Wildlife Characterization Baseline Report ([Appendix 18-A](#));
- Brucejack Gold Mine Project Wildlife Habitat Suitability Report ([Appendix 18-B](#));
- Air Quality Predictive Study (Chapter 7);
- Water Quality Predictive Study ([Appendix 13-C](#));
- Predicted Metal Concentrations in Soils and Vegetation Tissues;
- Predicted Metal Concentrations in Vegetation due to Root Uptake of Metals from Soil and Direct Deposition of Metals in Dustfall for the Operation Phase of the Brucejack Gold Mine Project ([Appendix 21-F](#)); and
- Predicted Metal Concentrations in Berries due to Root Uptake of Metals from Soil and Direct Deposition of Metals in dustfall for the Operation Phase of the Brucejack Gold Mine Project ([Appendix 21-G](#)).

Hazard quotients (HQs) were calculated by dividing the predicted mean concentrations of a metal by the guideline limit in each relevant environmental medium. COPCs with a HQ less than 1.0 were screened out of the wildlife chemical effects assessment, since these metals would not be expected to cause adverse effects in wildlife receptors. Metals without a guideline were retained for a second screening step if they were considered bioaccumulative. However, if metals without a guideline were not categorized as bioaccumulative, no further assessment was done and they were not considered a Project related COPC.

Metals with a HQ greater than 1.0 relative to the guideline and metals without guidelines that were considered bioaccumulative were retained for a second screening step. In the second screening step, the predicted metal concentrations were compared to the mean baseline concentration plus mean baseline concentration coefficient of variation. This baseline concentration was selected because considering spatial variability, field sampling variability, variability in laboratory methods, and

conservatism within the modelling, any contaminant concentration less than the selected baseline concentration is unlikely to be sufficiently distinguishable from background levels to be considered a Project-related effect. This step was done to ensure that all COPCs identified and carried through the wildlife chemical assessment process were only those COPCs with concentrations that were predicted to increase due to Project-related activities.

At the end of the screening process for each environmental medium, any metals that had:

- either a HQ greater than 1.0 relative to guideline and a HQ greater than 1.0 relative to baseline concentrations,
- or no guideline with bioaccumulative potential and a HQ greater than 1.0 relative to baseline concentrations,
- were retained as COPCs in the wildlife chemical hazard assessment for their potential to cause health effects in wildlife receptors.

Because wildlife take up contaminants from environmental media (i.e., freshwater, sediment, soil, vegetation, and prey), the quality of the food is directly related to the quality of the environmental media. To determine the potential effects to wildlife, predicted changes to the environmental media were screened against relevant guidelines and baseline concentrations for each relevant environmental medium. Therefore, the methodology explained above was used for each of the environmental media that could result in changes to quality of prey consumed by carnivorous wildlife. If the predicted concentrations of metals in each of the environmental media were either below guidelines or below or equal to baseline levels, then there would be no predicted wildlife effects due to changes in the quality of prey.

In the case where a COPC in environmental media were retained for the wildlife chemical hazard assessment, individual wildlife VCs were screened for their potential to overlap the areas anticipated to result in elevated concentrations of COPCs using data from the baseline studies (Section 18.3; [Appendix 18-A](#)) and habitat suitability modelling results (Section 18.3; [Appendix 18-B](#)). If wildlife VCs and their habitat (high-quality habitat) are not present in the areas predicted to result in elevated COPC concentrations, these wildlife VCs were screened out of further wildlife chemical hazard assessment.

If a wildlife VC or their high-quality habitat is present in areas predicted to result in elevated concentrations of COPCs (as described above), wildlife were also screened for their potential to uptake the retained COPC (route of exposure). Only wildlife VCs deemed to include a route of exposure necessary for uptake of the COPC were further retained for chemical hazard assessment, and the interaction was then evaluated for the potential to result in residual effects on the VC in Section 18.6. A total of five VCs including moose, mountain goat, grizzly bear, American marten, and hoary marmot were retained for the assessment of health risks due to COPCs, as summarized in Table 18.5-3 and described below.

#### Chemicals of Potential Concern Associated with Mine Construction and Operation

Chemicals associated with mining activities include those used by the mine during the Construction and Operation phases. Chemicals used on-site will include materials such as fuel, oil and waste oil, hydraulic fluid, explosives, flocculants, chemical reagents and solvents, lead acid batteries, oil filters, etc. These chemicals will be stored and handled according to safe handling and storage procedures (Chapter 5, Project Description; Section 29.7, Hazardous Materials Management Plan; and Section 29.17, Waste Management Plan) and are not anticipated to be released into the environment. However, wildlife may be attracted to odours associated with camps and Project-related activities (Section 18.5.6). During Closure and Post-closure phases, some chemicals may be used (e.g., fuel, oil, etc.), but the amounts used are anticipated to be minimal, thus these phases are not considered further.

There is a potential for residual effects resulting from COPC if wildlife are attracted to areas of Project operation and able to access chemical storage areas. Baseline studies and Section 18.5.6 (Attractants) identified grizzly bears, and American marten as two wildlife VCs that may be attracted to odourous chemicals stored at camps and Project facilities. However, mitigation measures for attractants (Section 18.5.6.1, Mitigation for Attractants and Section 29.21, Wildlife Management and Monitoring Plan) are designed to minimize the effects of attractants on wildlife VCs. Chemicals of Potential Concern associated with the Construction and Operation phases of the Project are assessed for grizzly bear and American marten.

#### Chemicals of Potential Concern in Water

Water quality is a key indicator of environmental health as it is linked to wildlife which consume surface water. Several Project-related activities have the potential to result in changes to surface water quality within the wildlife LSA and could result in downstream effects if not mitigated. Project activities that could result in erosion and sedimentation, metal leaching and acid rock drainage, leaching of nitrogen residues from blasting, atmospheric deposition, discharges of effluent, and groundwater interactions and seepage, have the potential to change water quality and are discussed in detail in Chapter 13 (Surface Water Quality). The evaluation of residual effects to surface water quality during all Project phases is assessed in Section 13.6.

Water quality guidelines for the protection of wildlife (BC MOE 2010c) were used as the standard to evaluate the potential effects of COPC in water on wildlife VCs. Where there are no guidelines specific for wildlife (e.g., cadmium), water quality guidelines for the protection of aquatic life (BC MOE 2010c) were used. Hereafter, any reference to “water quality guidelines” refers to this combination of wildlife and aquatic guidelines, unless stated otherwise. These water quality guidelines are listed in Table 18.5-4. Where they exist, wildlife guidelines have thresholds at equivalent or higher concentrations to those for the protection of aquatic life (with the exception of molybdenum, which is lower).

**Table 18.5-4. Wildlife Guidelines for Water Quality**

Element	Aquatic Life Guideline	Wildlife Guideline
Aluminum (Al)	-	5 mg/L
Antimony (Sb)	20 µg/L	-
Arsenic (As)	5 µg/L	25 µg/L
Barium (Ba)	1 mg/L	-
Beryllium (Be)	5.3 µg/L	-
Boron (B)	1.2 mg/L	5 mg/L
Cadmium (Cd)*	0.01 - 0.04 µg/L	-
Chromium (Cr)	1 µg/L	-
Cobalt (Co)	40 µg/L	-
Copper (Cu)*	1.5 - 3.0 µg/L	300 µg/L
Cyanide WAD	5 µg/L	50 mg/L
Iron (Fe)	1 mg/L	-
Lead (Pb)*	4.2 - 7.5 µg/L	100 µg/L
Lithium (Li)	96 µg/L	-
Manganese (Mn)*	2.2 - 6.1 µg/L	-
Mercury (Hg)	0.02 µg/L	0.02 µg/L
Molybdenum (Mo)	1 mg/L	0.05 mg/L
Nickel (Ni)*	65.5 - 113.2 µg/L	-

(continued)

**Table 18.5-4. Wildlife Guidelines for Water Quality (completed)**

Element	Aquatic Life Guideline	Wildlife Guideline
Selenium (Se)	2 ug/L	4.0 ug/L
Silver (Ag)*	0.05 - 1.5 µg/L	-
Thallium (Tl)	0.3 ug/L	-
Uranium (U)	300 ug/L	-
Vanadium (V)	6 ug/L	-
Zinc	7.5 ug/L	2 mg/L
Dissolved Aluminium (Al)	50 ug/L	-
Dissolved Iron (Fe)	350 ug/L	-

\*Guideline range dependent on water hardness. See BC MOE (n.d.).

Two main Project areas were evaluated for exposure of wildlife to COPC in water including:

1. within Brucejack Lake and outflow; and
2. lower Brucejack Creek (BJ2 or 200 m downstream).

The concentrations of candidate COPC were examined in each of these locations during the Construction, Operation, Closure, and Post-closure phases using HQs for modelled water quality parameters (Section 13.6) against water quality guidelines for wildlife (Table 18.5-4) in order to assess if the candidate COPC should be evaluated for potential effects on wildlife VCs. The results are listed in Table 18.5-5.

**Brucejack Lake:** At the mine site area, Brucejack Lake is the site of waste rock and tailings disposal during Construction, Operation, and Closure phases of the Project. Brucejack Lake will also receive site contact water, and water treatment plant (WTP) and sewage treatment plant (STP) treated discharges. Predicted water quality modelling within Brucejack Lake indicated that two COPCs are anticipated to exceed wildlife water quality guidelines in the base case and maximum (upper) case scenarios (Table 18.5-5 and [Appendix 13-C](#)). Manganese concentrations are predicted to exceed guidelines during all Project phases under low flow conditions, and during the Operation, Closure and Post-closure phases under high flow conditions; post-closure low flow concentrations are slightly higher than baseline concentrations (Table 18.5-5). Cadmium is predicted to exceed guidelines under low flow conditions during both the Operation phase (in the maximum predicted scenario) and during Closure (in the mean and upper case scenarios; Table 18.5-5) but to return to baseline conditions at Post-closure.

**Lower Brucejack Creek (downstream receiving environment, BJ2):** Brucejack Creek is the receiving environment of water discharged from Brucejack Lake. Predicted water quality modelling within lower Brucejack Creek indicated that several COPC are anticipated to exceed wildlife water quality guidelines in the base case and maximum case scenarios (Table 18.5-5; and [Appendix 13-C](#)). Base case manganese concentrations are predicted to exceed guidelines during all Project phases in Brucejack Creek under low flow conditions and in the Construction and Operation phase only during high flow conditions. Under the upper case scenario, manganese is anticipated to exceed guidelines during the Construction phase under both low and high flow conditions and in the Operation phase under high flow conditions. Mean predicted cadmium concentrations are anticipated to exceed guidelines in the Construction, Closure and Post-closure phases under low flow conditions. Silver is anticipated to exceed guidelines under low flow conditions in both the Closure phase (upper case prediction scenario only), and in the Post-closure phase (both in the mean and upper case scenarios). No residual effects on water quality were predicted downstream of Brucejack Creek, in Sulphurets Creek or the Unuk River (Section 13.6). Thus, potential effects of COPCs in water on wildlife were limited to Brucejack Lake and Brucejack Creek at the mine site area.



No residual effects were predicted to occur on surface water quality in the road access area (Chapter 13, Section 13.6.4). Due to the mitigation measures in place (Chapter 13, Section 13.4.3) and Project design, there will be no effluent, waste rock, or tailing discharges to water bodies within the Brucejack Access Road area. Road rehabilitation, maintenance, and dust generated from the use of the road will be the only possible sources of contamination into the water bodies within the road corridor. However, these sources are considered negligible and therefore, water quality within the access road area of the wildlife LSA is not expected to be affected by any of the Project related activities or infrastructures during the Construction, Operation, Closure, or Post-closure phases of the Project. Thus, potential effects of COPCs in water on wildlife were limited to the mine site assessment area.

Baseline studies ([Appendices 18-A](#) and [18-B](#)) indicated that the mine site assessment area located at high elevation is relatively poor habitat for the majority of wildlife VCs, with a high proportion of exposed rock and glacier. Brucejack Lake and Brucejack Creek have not been identified as important areas for bird and amphibian VCs during baseline conditions and are likely limited only to VCs that use higher elevation areas, including mountain goat, grizzly bear, and hoary marmot. Wildlife are anticipated to largely avoid the mine site footprint during the Construction and Operation phases of the Project due to habitat loss and alteration (Section 18.5.2) and sensory disturbance (Section 18.5.3). During Closure and Post-closure phases, wildlife may resume use of these areas as disturbances subside.

Wildlife VCs that were retained for the assessment of exposure to COPCs in water from the mine site assessment area include mountain goat and hoary marmot. While grizzly bear high-quality habitat exists at the mine site area, and grizzly bear could potentially access water from Brucejack lake, grizzly bear was excluded from the assessment as they have very large home ranges (1,280 ha and 6,920 ha for mean female and male home range sizes) which would limit their interaction with water from the mine site assessment area. As grizzly bears travel large distances on a daily basis, which encompasses many other sources of drinking water within their range, resulting in Brucejack Lake being used a very low percentage of the time. Due to their large size, any COPCs taken up from water from Brucejack Lake, would likely result in no changes to current baseline tissue concentrations. Thus, grizzly bears were not assessed for COPCs in water.

#### Chemicals of Potential Concern in Metal Leaching and Acid Rock Drainage

Acid rock drainage (ARD) occurs when sulphide minerals are exposed to oxygen and water and naturally oxidize without the presence of sufficient quantities of neutralizing minerals. The potential for wildlife exposure to COPC as a result of ML/ARD is assessed for all phases of the Project.

Within the mine site area, ML/ARD has the potential to occur as a result of surface disturbances during the Construction phase and subsequent weathering of newly exposed rock. Other potential Project-specific sources of ML/ARD within the mine site area include:

- the upper laydown area where the waste rock transfer and pre-production ore will be stored during the initial Construction phase;
- the WTP, mill building, and portal sites, which require extensive cuts into the bedrock (some of which are currently presumed to be PAG);
- construction and use of diversion channels (contact and non-contact water);
- grading of the mine site area; and
- subaqueous deposition of tailings and waste rock into Brucejack Lake.

Contact water with the upper laydown area during the initial stages of the Construction phase, and subsequent runoff and tailings disposal, could potentially result in effects to water in Brucejack Lake. As

wildlife will likely not access the upper laydown area during the Construction phase of the Project due to habitat loss (Section 18.5.1) and sensory disturbance (Section 18.5.2), and considering that the effects of COPCs in ML/ARD are primarily associated with changes to water quality in Brucejack Lake (Chapter 13), uptake of COPCs in ML/ARD by wildlife are considered with uptake of COPCs in water by wildlife.

In the access road area, ML/ARD has the potential to occur as a result of surface disturbances during the Construction phase and subsequent weathering of newly exposed rock. Potential Project-specific sources of ML/ARD in off-site areas include:

- upgrades to the existing 75 km exploration road to accommodate mine traffic (Section 5.7.4);
- replacement of the existing overgrown airstrip in the Bowser River Valley (Bowser Aerodrome); and
- construction and use of the Knipple Transfer Area and storage areas near the base of the Knipple Glacier.

However, the potential for effects along the access road area were considered to be low (Section 13.5.3.2) as the level of disturbance with respect to exposing new rock will be relatively low. Similarly, effects to wildlife associated with ML/ARD and water quality are anticipated to be low in these areas, and not considered further. Mitigation measures for ML/ARD are summarized in Section 13.5.4.2.

#### Chemicals of Potential Concern in Fugitive Dust

Project-related activities that can produce fugitive dust during the Construction phase include site clearing, blasting, drilling, rock crushing, road grading, and truck and conveyor transport activities. Main sources of fugitive dust during the Construction phase are from use of the Brucejack Access Road, and transport of the waste rock, ore, and overburden. During the Operation phase, fugitive dust emissions from the access road, transport of waste rock during the mining operation and other mining processes are the main sources of dust. Since the Project effects on dust deposition during the Closure and the Post-closure phases will be limited and intermittent, such effects are expected to be less significant than those experienced during the Construction and Operation phases, and concentrations at the end of the Operations phase are anticipated to be higher relative to these other project phases. COPCs associated with fugitive dust were scoped out of the assessment as no COPCs were anticipated to occur above HQs based on CCME guidelines for soil and health effects (Chapter 11 and Chapter 21).

#### Bioaccumulation of Chemicals of Potential Concern in the Food Web

In addition to the potential effects of direct exposure (e.g., ingestion) of COPC from environmental media (water, soil, and vegetation) in the LSA, wildlife VCs were evaluated for the potential effects of bioaccumulating COPC and/or biomagnification through the food web. This was evaluated because in some cases wildlife species, such as top predators, can accumulate high concentrations of persistent COPC, even when these concentrations are relatively low in environmental media such as water and soils (Beatty and Russo 2012). The inclusion of bioaccumulation as a source of COPC for wildlife ensures a conservative assessment of the potential effects on wildlife VCs.

Sources of COPC include those in water and ML/ARD rock that may enter a food web when they are partitioned into soil, vegetation, and lower trophic organisms. These are fed upon by lower trophic level organisms such as insects or herbivorous mammals, which are in turn consumed by predators. Depending on the type of chemicals involved, COPC may bioaccumulate at one or all of these steps.

Chemicals of potential concern that have the potential to bioaccumulate in wildlife were evaluated using hazard quotient ratios and included selenium, mercury, and molybdenum. These COPCs are

unique among metals and metalloids in that their primary route of uptake is through the diet and are therefore assessed for potential effects due to bioaccumulation (Chapman et al. 2009). However, while selenium and molybdenum bioaccumulation is possible in most wildlife, elevated concentrations of these COPCs in tissues of most mammals (excluding ungulates) do not appear to cause negative impacts to these organisms (reviewed in Puls 1994; Janz et al. 2010). While a bioaccumulation potential is possible for ungulates, these mammals are herbivores. Thus, effects of uptake of bioaccumulative COPCs in these animals would be through direct exposure to soil and vegetation, and the effects of bioaccumulation in these mammals would be considered, as described above (in COPCs in water). Mercury concentrations in soil and vegetation were within 10% of baseline conditions, and consequently considered within the margin of modelling error. Thus, mercury is not anticipated to bioaccumulate in wildlife as a result of Project-related activities.

Therefore, only top predators (grizzly bears) were evaluated for bioaccumulation of persistent COPCs through the food web. Bioaccumulation of COPCs in grizzly bears is dependent on increases of bioaccumulative COPC concentrations in prey. Thus, if no increases in COPC concentrations, as a result of the Project, are anticipated in prey species such as fish, small mammals and ungulates, bioaccumulation of these COPCs is not anticipated to result in top predators such as grizzly bears.

#### *18.5.7.2 Mitigation for Chemical Hazards*

To minimize the potential effects due to chemical hazards, the following mitigation measures will be carried out.

#### Mitigation of Chemicals of Potential Concern Associated with Mine Development and Operation

Chemicals will be stored and transported according to BMPs and legislative requirements. All chemical storage and handling will meet the specifications identified and detailed in the following plans:

- Hazardous Materials Management Plan (Section 29.7);
- Waste Management Plan (Section 29.17); and
- Spill Prevention and Response Plan (Section 29.14).

#### Mitigation of Water Quality

Mitigation for the degradation of water quality is detailed in Section 13.5 (Effects Assessment and Mitigation for Surface Water Quality). Extensive mitigation and management of Project effects on surface water quality was included in the design for the proposed Brucejack Project. Proposed mitigation strategies include measures to avoid, reduce, and monitor adverse effects to surface water quality. Details of mitigation and management strategies relevant to the surface water quality are available in the following EA Chapters:

- Chapter 7, Air Quality Predictive Study;
- Chapter 9, Hydrogeology Predictive Study;
- Chapter 10, Surface Water Hydrology Predictive Study;
- Chapter 11, Terrain and Soils Predictive Study;

Additional mitigation and management measures relevant to surface water quality are provided in the following environmental monitoring and management plans:

- Section 29.1, Air Quality Management Plan;

- Section 29.3, Aquatic Effects Monitoring Plan;
- Section 29.7, Hazardous Materials Management Plan;
- Section 29.10, ML/ARD Management Plan;
- Section 29.13, Soils Environment Management Plan;
- Section 29.14, Spill Prevention and Response Plan;
- Section 29.19, Water Management Plan; and
- Chapter 30, Closure Plan.

#### Mitigation of Metal Leaching and Acid Rock Drainage Exposed Rock

Strategies to minimize potential adverse environmental effects of tailings disposal are summarized in the proposed Mitigation Measures for Surface Water Quality Effects (Section 13.5.2 and Section 13.5.4) and detailed in the ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18), Tailings Management Plan (Section 29.15), and the Water Management Plan (Section 29.19). Mitigation and management measures for ML/ARD will also include the re-establishment of vegetation cover during site restoration and reclamation, as detailed in Chapter 16 (Assessment of Potential Terrestrial Ecology Effects) and site closure and reclamation plans (Chapter 30).

The planned waste rock and tailings management strategies at the Brucejack Mine Site involve disposal in (1) the underground workings, and (2) Brucejack Lake (Chapter 5, Project Description). During sub-aqueous deposition in Brucejack Lake, sufficient water cover over the waste rock deposits will be maintained to limit exposure to air.

ML/ARD will be monitored in water per the technical indicators contained in the Aquatic Effects Monitoring Plan (Section 29.3.5) and the Water Management Plan (Section 29.29), during the Construction, Operation, Closure, and Post-closure phases of the Project such that any anomalies in these indicators can be adaptively managed.

#### Mitigation of Bioaccumulation in the Food Web

Uptake of COPC into the food web will be mitigated by implementing the management plans for COPC in water, and ML/ARD rock and those used in the development and operation of the mine (described above), as these plans will limit exposure of wildlife VCs to COPC bioaccumulated through the food web. In addition to the previously mentioned management and mitigation plans, the following contaminant prevention and monitoring plans will be implemented to monitor the uptake of COPC and elements in environmental media and biota:

- Soil Metal Contamination Prevention Plan (e.g., monitoring COPC in soil; Section 29.13.5);
- Wetlands Monitoring Plan (e.g., monitoring COPC in wetland vegetation; Section 29.20); and
- Aquatic Effects Monitoring Plan (AEMP; e.g., monitoring COPC in benthic invertebrates, water, and fish; Section 29.13).

Based on monitoring results, adaptive management and mitigation will be implemented where necessary.

## 18.6 RESIDUAL EFFECTS ON WILDLIFE

From the scoping assessment, seven potential effects were identified: habitat loss and alteration, sensory disturbance, disruption of movement patterns, direct mortality, indirect mortality, attractants, and chemical hazards. Each of these potential residual effects is discussed in further detail in the following sections for each wildlife VC (Section 18.6-1 to 18.6-10), followed by characterization of the residual effects and significance determinations for each wildlife VC (Section 18.7).

This effects assessment primarily focuses on potential effects on local populations within the RSA or, in some cases (e.g., for species with small home ranges such as hoary marmot), within the LSA. The assessment considers the statutory requirements and policy statements which influence wildlife management. These include provincial and federal legislation, policies, and best management practice guidelines applicable to wildlife and wildlife habitat in BC. The assessment also considers wildlife objectives and management direction outlined in relevant LRMPs, SRMPs, and wildlife policy documents.

The wildlife effects assessment was prepared according to applicable best management guidelines and the *Environmental Assessment Best Practice Guideline for Wildlife at Risk in Canada* (Environment Canada 2004), and in accordance with Section 9.7 of the AIR (BC EAO 2014). The assessment is based on current available knowledge of species behaviour, presence, distribution, population biology, and ecology. Consideration is also given to linkages between potential effects from the proposed development that occurs on both the individual (e.g., an animal's response to noise) and local population level (e.g., population change due to altered habitat), where applicable.

### 18.6.1 Potential Residual Effects on Moose

#### 18.6.1.1 Identifying Key Effects

Moose were assessed for potential Project related effects. Habitat loss and alteration, sensory disturbance, disruption of movement, direct mortality, indirect mortality, attractants, and chemical hazards were considered for the effects assessment because these effects have the potential to create a residual effect on moose. All seven potential effects are considered in the assessment of effects on moose. The potential residual effects considered in the assessment for moose are summarized in Table 18.6-1 and described in the following sections, from Section 18.6.1.2 to 18.6.1.8.

#### 18.6.1.2 Habitat Loss and Alteration

This assessment evaluates the effects of habitat loss and alteration on moose. Potential effects due to habitat loss may occur in areas where Project infrastructure (i.e., the Brucejack Mine Site, Bowser Aerodrome, Knipple Transfer Area, and Brucejack Transmission Line) overlaps high-quality moose habitat.

Winter habitat is generally considered to limit the number of moose that can be supported by a land base. Metabolic demands increase in winter because of the effort required to move through deep snow packs and tolerate colder weather (Safford 2004a), and this occurs during a season where forage has a lower nutritional value. The quality and quantity of forage available in winter influences how quickly summer fat reserves are depleted, thereby affecting changes of survival and reproduction (BC MELP 2000). Conservation of ungulate winter range is an objective of the land and resource management plans associated with the LSA and RSA for these reasons (i.e., Nass South SRMP, CIS LRMP). Therefore, the assessment of habitat loss and alteration due to the Project focuses on the loss and alteration of winter range for moose.

High-quality habitat is defined for this assessment as High and Moderately High suitability habitat (HSR 1 and 2) identified from the Habitat Suitability Modeling ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

Table 18.6-1. Ranking Potential Effects on Moose

Project Components/Physical Activities	Potential Effects on Moose						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/Brower Aerodrome	●	●	●	●	●	●	○
Access Road	○	●	●	●	●	●	○
Transmission Line	●	●	●	●	●	●	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/Brower Aerodrome	●	●	●	●	●	●	○
Access Road	○	●	●	●	●	●	○
Transmission Line	●	●	●	●	●	●	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/Brower Aerodrome		●	●	●	●	●	○
Access Road	○	●	●	●	●	●	○
Transmission Line		●	●	●	●	●	○

Notes:

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

Moose Habitat Requirements and Availability

The assessment of habitat loss and alteration for moose focuses on the area of high-quality early and late winter habitat lost within the Project footprint compared to that available in the LSA and RSA. The habitat suitability modelling identified high-quality winter habitat using a combination of the availability of high-quality winter browse, snow depth, thermal cover, and predation risk, which is a RISC-standard approach (Dussault, Ouellet, et al. 2005). Early winter and late winter habitat were modelled and evaluated separately. Early winter habitat is largely defined by forage availability. However, during late winter, the increasing snow depth restricts moose range into a smaller area in valley bottoms.

Overall, 56,703 ha of high-quality early winter moose habitat was identified within the RSA (15% of the RSA), and 3,995 ha was identified within the LSA (12.5% of the LSA; excluding 1,278 ha of previously disturbed area along the access road). High-quality habitat was largely concentrated in the interior-influenced area of the RSA along the Bowser River, between Bowser Lake and Knipple Lake, within the Todedada wetland complex, along the Bell-Irving River, and the lower Treaty Creek drainage (Appendix 18-B, 2013 Wildlife Habitat Suitability Report). Very little high-quality habitat was available in the coastal-influenced areas of the Unuk River, due to steeper topography.

Within the RSA, 22,295 ha of high-quality late winter habitat were identified (6% of the RSA), while 2,016 ha of late winter habitat was present in the LSA (6% of the LSA; excluding 341 ha of previously disturbed habitat along the access road). The distribution of high-quality late winter habitat was similar to the early winter habitat, particularly along the Bowser River floodplain, the Bell-Irving River, and Treaty Creek. These areas were also proposed as a UWR for moose (UWR 6-018) under the FRPA, which is 51,476 ha; 26,807 ha are within the RSA and 993 ha are within the LSA along the access road. Aerial survey data from late winter confirms that areas modelled as high-quality winter habitat contained the majority of moose in the RSA (Appendix 18-B, 2013 Wildlife Habitat Suitability Report).

During baseline surveys conducted in winter 2011 (Appendix 18-A, 2013 Wildlife Characterization Baseline Report), 174 moose (adjusted for sightability) were observed, the majority of which (92%) were observed within the interior-influenced portion of the RSA along the Bell-Irving River, Treaty Creek, and Bowser Lake. Density of moose within the interior-influenced portion of the RSA and coastal portion of the RSA was 0.34 moose/km<sup>2</sup> and 0.13 moose/km<sup>2</sup> of capable habitat (adjusted for sightability), respectively.

#### Moose Habitat Loss and Alteration

**Early Winter:** Habitat mapping identified 56,703 ha of high-quality early winter habitat for moose in the RSA. Of this area, 63 ha (0.1% of the RSA; 1.6% of the LSA) will be lost or altered (i.e., Project assessment footprint) as a result of Project development (Table 18.6-2; Figures 18.6-1a and 18.6-1b). Most of this loss and alteration (38 ha, 60%) will occur during vegetation clearing for the Brucejack Transmission Line (26 ha) and the Bowser Aerodrome (12 ha; Figure 18.6-1b).

**Table 18.6-2. Moose Habitat Loss and Alteration due to the Project**

Season	Habitat Lost and Altered (ha)	RSA		LSA	
		Total Habitat <sup>1</sup> (ha)	Habitat Lost/ Altered (%)	Total Habitat <sup>1</sup> (ha)	Habitat Lost/ Altered (%)
Early Winter	63	56,703	0.1	3,995	1.6
Late Winter	25	22,295	0.1	2,016	1.2
Total Early and Late Winter	63	56,703	0.1	3,995	1.6
Proposed UWR 6-018	0	26,807	0	993	0

<sup>1</sup> Total habitat refers to high-quality habitat in the RSA and LSA; see text for definition of high-quality habitat.

**Late Winter:** Of the 22,295 ha of high-quality late winter habitat identified in the RSA for moose, 25 ha (0.1% of the RSA; 1.3% of the LSA) will be lost or altered (i.e., Project footprint and buffers) due to the Project (Table 18.6-2). Most of the habitat loss and alteration (48%) will occur in association with the development of the Bowser Aerodrome (12 ha).

In total, 0.1% of combined early and late winter habitat will be lost or altered within the RSA during the Operation phase (Table 18.6-2), and 1.6% within the LSA.

#### Residual Effects for Moose due to Habitat Loss and Alteration

Direct habitat loss and alteration is not predicted to result in a residual effect on moose. Very little (less than 1% of the RSA and less than 2% of the LSA) high-quality winter habitat will be impacted by the removal of habitat for Project facilities due to the high elevation of the mine site area (Section 18.3.4.1). Project infrastructure that falls within moose winter habitat is mainly limited to the Bowser Aerodrome and Brucejack Transmission Line. The majority of the high-quality moose habitat is primarily located along the Bowser River flood plain, associated with riparian vegetation along the Bell-Irving River, and along Treaty Creek. The amount of high-quality winter habitat that will be

affected (63 ha) is 0.1% of the total amount of winter habitat available in the RSA, and 1.6% of the total amount of winter habitat available in the LSA. Mean multiannual home range size for moose south of the RSA (NWA) is 17,130 ha, but can be as small as 990 ha, or as large as 79,170 ha (M. W. Demarchi 2003); therefore, the loss and alteration of winter habitat associated with the Project (63 ha) is a small percentage (less than 1%) of a moose's home range. Furthermore, the density of moose observed in the census area of the interior portion of the RSA was estimated at 0.42 moose per km<sup>2</sup> (or 0.0042 moose per ha); therefore, the loss of 63 ha of habitat may affect 0.26 moose. The effect of habitat loss and alteration on moose is expected to be negligible; therefore, no residual effect of habitat loss and alteration on moose is predicted. The 341 ha of previously disturbed habitat along the access road that is not included in the effects assessment will be covered in the cumulative effects assessment (Section 18.9.2.1).

### 18.6.1.3 Sensory Disturbance

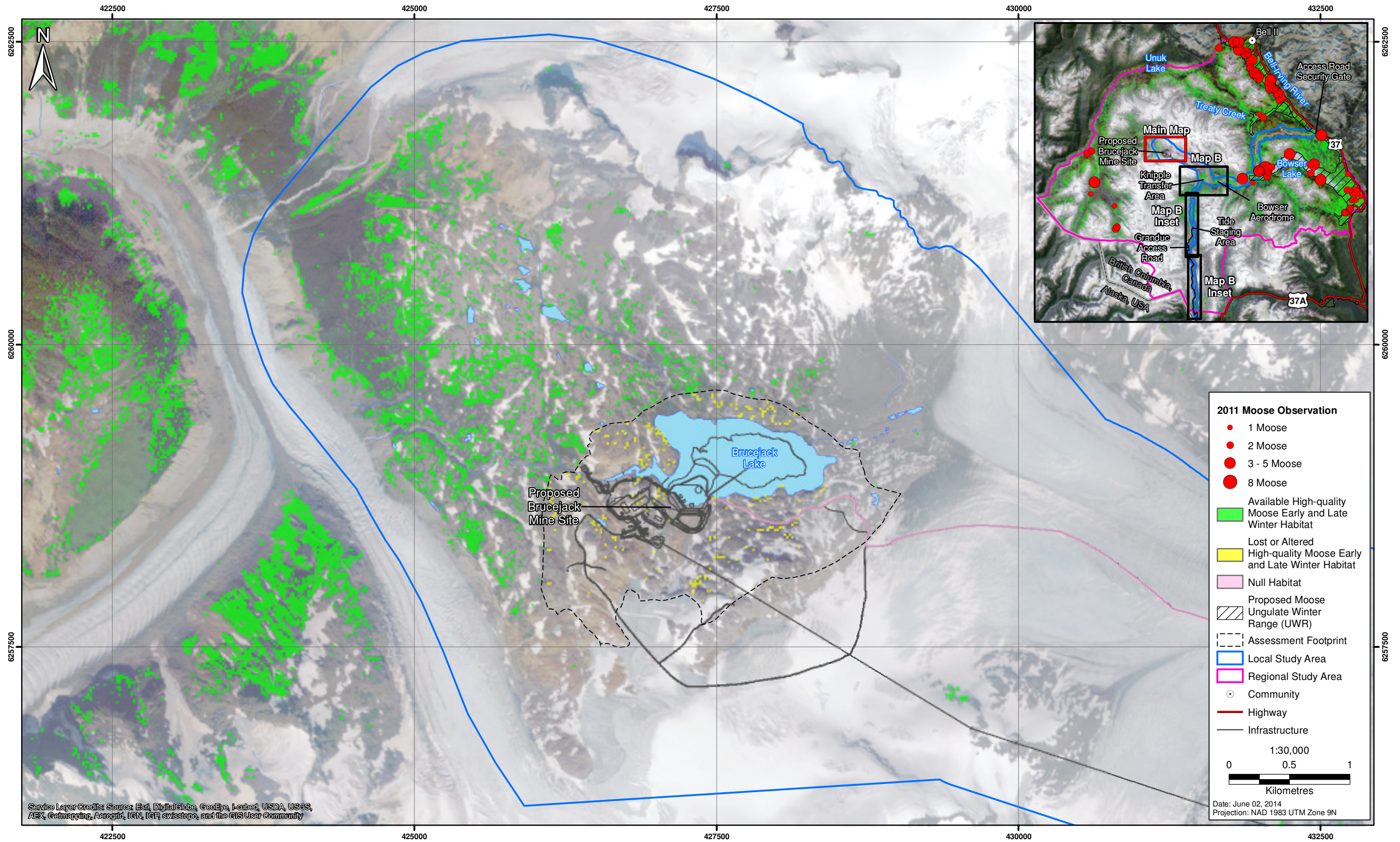
The various sources of sensory disturbance (noise and visual) may act together to result in functional loss of habitat, due to avoidance of high-quality habitats. Disturbance is evaluated because the scientific literature reports that mammal density can decrease up to 5 km away from industrial projects and avoidance distances are greater in open versus forested habitats (Benitez-Lopez, Alkemade, and Verweij 2010). Industrial activity can cause disturbance to wildlife that varies from short term (e.g., increased vigilance and short flight response) to long term. Long-term disturbance of ungulates can have several effects, including displacement of individuals or groups, earlier-than-usual migration, or changes in rates of movement (Van Dyke and Klein 1996).

Potential sources of sensory disturbance for moose associated with the Project include: 1) elevated noise levels associated with daily Project operation activities and human presence, 2) increased traffic along the access road, and 3) instantaneous blasting noise from the mine site area. Traffic noise and human presence could affect moose along Wildfire Creek and the Bowser River near the access road. Moose do not respond to aircraft if flights remain 200 m above ground level (R. Andersen, Linnell, and Langvatn 1996). Moose have been shown to have large flight distances in the presence of humans. For example, direct overflights by jet aircraft did not flush moose, whereas skiers and walkers caused moose to flush at distances of 200 to 400 m; however, ungulates have shown the capability to adapt to human presence when that presence is confined to predictable areas (R. Andersen, Linnell, and Langvatn 1996).

Noise modelling was completed to determine the area of moose habitat that may be functionally lost or disturbed due to sensory disturbance during Construction and Operation. The total area functionally lost equalled the amount of High and Moderately High suitability (high-quality) winter habitat (early and late winter combined) that fell outside of the area of direct habitat loss and alteration due to the footprint (Section 18.6.1.2), but within the noise level contours. Contours consisted of: 1) 45 dBA (for Project noise); 2) 75 dBA L<sub>AE</sub> (road traffic noise); 3) 80 dB L<sub>AE</sub> (aircraft noise); 4) 108 dB L<sub>peak</sub> (disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response), and; and 5) 120 dB L<sub>peak</sub> (functionally lost habitat from instantaneous blasting noise, resulting in abandonment of habitat).

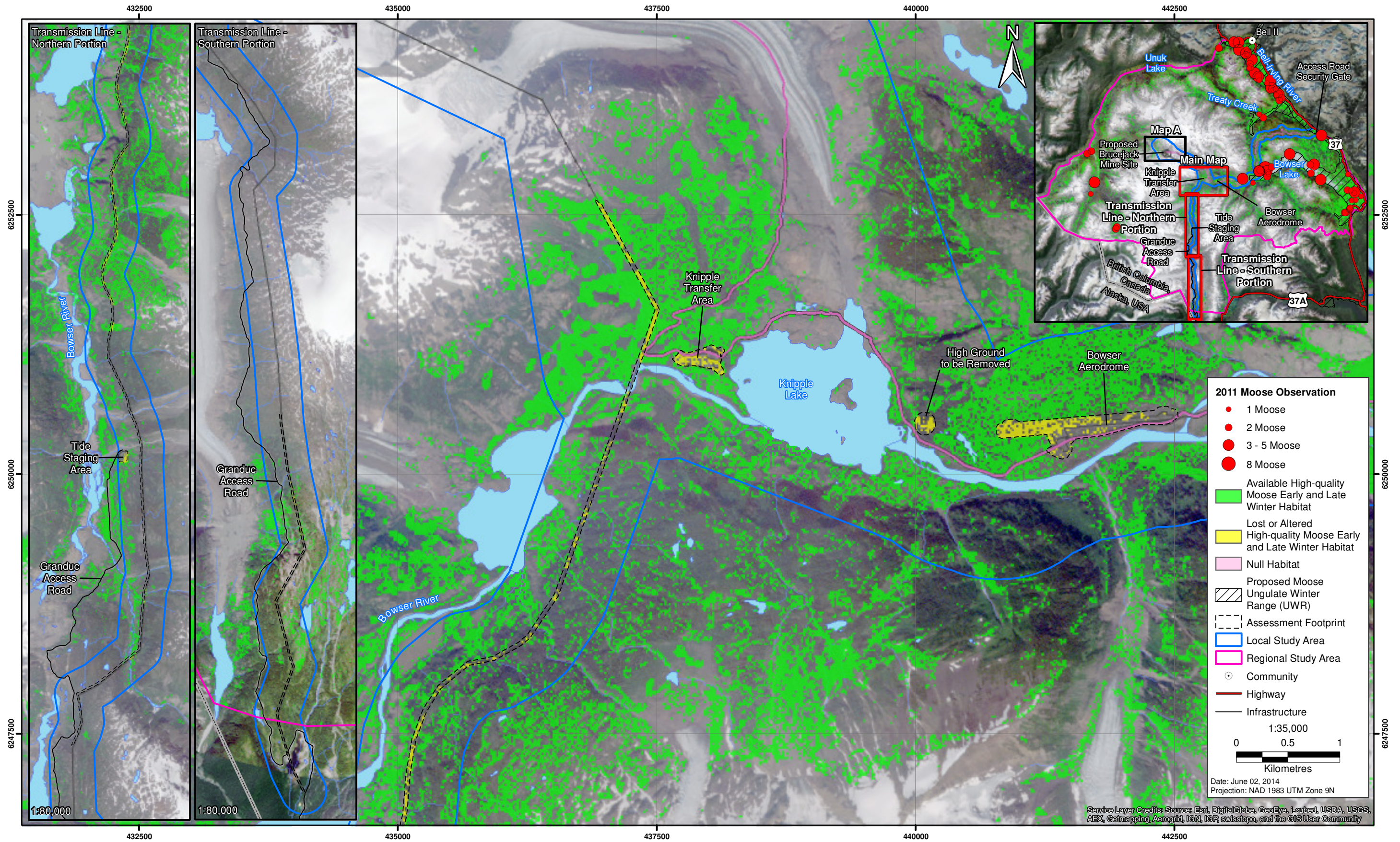
Traffic noise was included in Project noise models (45 dBA L<sub>n</sub>) averaged over the 12-hour period and evaluated as a continuous noise, which accounts for a minimal amount of disturbance. Traffic was also assessed as an instantaneous noise using a threshold of 75 dBA L<sub>AE</sub> to ensure the full extent of traffic disturbance was considered.

Figure 18.6-1a  
Moose High-quality Early and Late Winter Habitat Lost or Altered due to the Project



Service Layer Credits Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-1b  
Moose High-quality Early and Late Winter Habitat Lost or Altered due to the Project



**Project Noise:** The total amount of high-quality habitat affected by elevated Project noise levels (outside of the area already considered to be lost in Section 18.6.1.2) is 127 ha during Construction (Figure 18.6-2) and 163 ha during Operation (Figure 18.6-3). The majority of sensory disturbance during Construction will be associated with the transfer facility and aerodrome (58 ha) and along the access road between Highway 37 and the aerodrome (42 ha). During Operation, the majority (124 ha) of functional habitat loss will be associated with the transfer facility and aerodrome.

**Traffic Noise:** The total amount of high-quality habitat affected by elevated traffic noise levels during Operation (i.e., worst-case scenario) is 1,131 ha (2% of the available habitat in the RSA). The majority (949 ha affected) of this traffic noise is associated with traffic travelling along the access road between Highway 37 and the aerodrome.

**Aircraft Noise:** Fixed-wing aircraft arriving and departing from the aerodrome will only occur during Operation. The total amount of high-quality habitat affected by noise due to the aircraft arriving and departing from the aerodrome during Operation is 3,734 ha (7 and 48% of the available habitat in the RSA and LSA, respectively). The majority (1,821 ha affected) of this aircraft noise is associated with aircraft flying in from over Bowser Lake and in the Browser River valley west of the transmission line outside of the LSA, and 1,177 ha is associated with aircraft flying in along the access road to the aerodrome within the LSA.

**Blasting Noise:** During Construction, noise from blasting at the mine site area will result in behavioural disturbance to moose in 0.1 ha of habitat (108 dB), and no functional loss (120 dB) of high-quality winter habitat (Figure 18.6-2). Most of the blasting will occur underground, and is limited to high-elevation areas near the mine site area where there is limited to no high-quality moose habitat.

#### Residual Effects for Moose due to Sensory Disturbance

Moose winter habitat occurs at low elevations; therefore, sensory disturbance to moose is primarily associated with noise at lower elevations rather than near the mine site. Moose habitat within elevated noise levels is mainly associated with traffic noise (1,131 ha) and aircraft noise (3,734 ha) during Operation. However, traffic and aircraft noise is temporary (i.e., only remains for a short period of time per day). During Operation, one aircraft will be arriving and departing per day and no aircrafts will be operating during Construction. Therefore, the noise disturbance to 3,734 ha will be temporary and limited to a few minutes per day. Traffic along the access road will be 86 vehicles per day (3.6 vehicles per hour [VPH]). This is equivalent to one vehicle approximately every 17 minutes. Due to the temporary nature of both aircraft and vehicle noise, the effect is considered negligible. The mine is located at high elevation, outside of the winter range of moose; therefore, noise from blasting may result in disturbance (108 dB) to 0.1 ha of moose winter habitat, and is therefore considered negligible. After mitigation, no residual effect of sensory disturbance on moose is anticipated.

#### *18.6.1.4 Disruption of Movement*

Disruption of moose movement may occur as a result of disturbance from access roads or from infrastructure along valleys (e.g., near the Bowser Aerodrome) and therefore is evaluated in this section.

Moose generally have two seasonal home ranges. During summer, moose prefer wetlands and open areas where forage is abundant, but during winter they prefer closed forests where snow depth is shallower than in open areas (Dussault, Courtois, et al. 2005). In the NWA, collared moose were observed migrating up and down river drainages, moving between their seasonal ranges (M. W. Demarchi 2003). Migratory behaviour in moose is apparently learned, as young individuals follow the movement patterns of their mothers, both in terms of seasonal home ranges and migration routes (Sweanor and Sandegren 1989). As a result, migratory movements often follow traditional routes, using

the same migration corridor every year, but patterns of migration may vary from year to year, depending on extent and duration of snowfall (Bowyer, Ballenberghe, and Kie 2003).

The Bell-Irving, Bowser, and Todedada valleys all contain high-quality habitat for moose, including suitable habitat for early winter and the growing season at higher elevations associated with the drainages. These valley systems are connected together and likely facilitate moose movement between seasonal ranges within the RSA. Both the Scott Creek and Wildfire Creek valleys are expected to provide movement corridors from higher ranges at their head waters with high-quality late winter range in the flood plains of the Bowser River to the south and Bell Irving River to the east. Moose have been observed in each of these areas during surveys and incidentally ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). Since these valleys could be used as movement corridors, using the precautionary principle, this assessment considered the Bowser, Wildfire, and Todedada valleys as movement corridors for moose. Infrastructure within these valleys that could disrupt movement may include the Brucejack Access Road, the Bowser Aerodrome, and the Knipple Transfer Area. The Tahltan have expressed concern over the impact of Project roads on the moose corridors.

The effects of the access road on moose are likely to be related primarily to both the physical presence of vehicles and humans and to the presence of the road itself (Beazley et al. 2004; Beazley et al. 2005). During winter, the ploughed access road will provide relatively effective and energy efficient means of travel for moose; however, the presence of moose along the road will increase the risk of moose/vehicle-related interactions (Section 18.6.1.5, Direct Mortality). Planned mitigation measures include the ploughing of refuge areas and the inclusion of gaps at regular intervals along the road to provide escape routes for moose (Section 29.21, Wildlife Management and Monitoring Plan). Studies have shown roads may act as effective barriers if traffic volumes exceed 10,000 vehicles per day (Seiler 2005). However, traffic volumes due to the Project along the access road will be substantially lower, at 86 vehicles per day (i.e., less than 1/100th of the rate that can effectively block movement). Therefore, traffic is not anticipated to act as a complete barrier to movement for moose. However, the presence of the road and low traffic volume may still act as a partial barrier to movement for moose.

#### Residual Effects for Moose due to Disruption of Movement

Despite mitigation presented in Section 18.5.3.1, the effect of disruption of movement is predicted to result in a residual effect on moose due to the presence of the road. The presence of infrastructure along Bowser River and Wildfire Creek (the access road) and low traffic volumes are expected to disrupt and partially alter or limit moose movement through these areas.

##### *18.6.1.5 Direct Mortality*

Potential effects of direct mortality on moose could occur because of vehicle collisions in areas where roads used by the Project overlap high-quality moose habitat. Direct mortality of moose caused by vehicle collisions may occur during the proposed Project Construction, Operation, and Closure phases. Vehicle-moose collisions may occur along Project roads.

In general, vehicle-moose collisions tend to be aggregated in both time and space. Temporal patterns include changing food availability, seasonal migrations, and snow cover, while spatial factors include location of preferred foraging habitat, landscape topography, and road and traffic characteristics. Increased collision risk with animals is also associated with linear landscape features that funnel animals alongside or across roads, such as riparian corridors, transmission lines, and steep slopes and ridges, as well as with moose density (Seiler 2005).

Figure 18.6-2  
Functional Loss of High Quality Habitat for Moose due to Noise - Construction

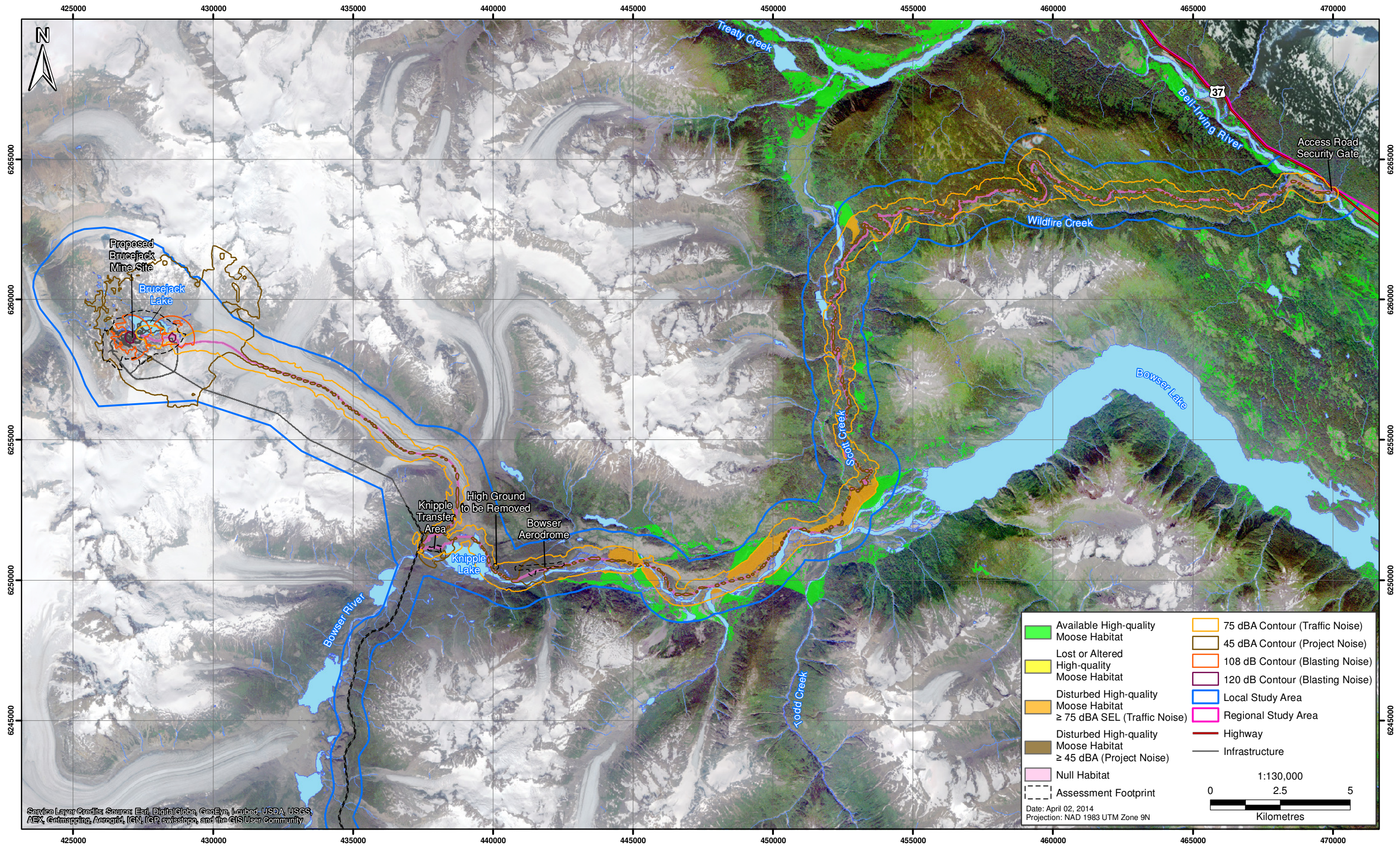
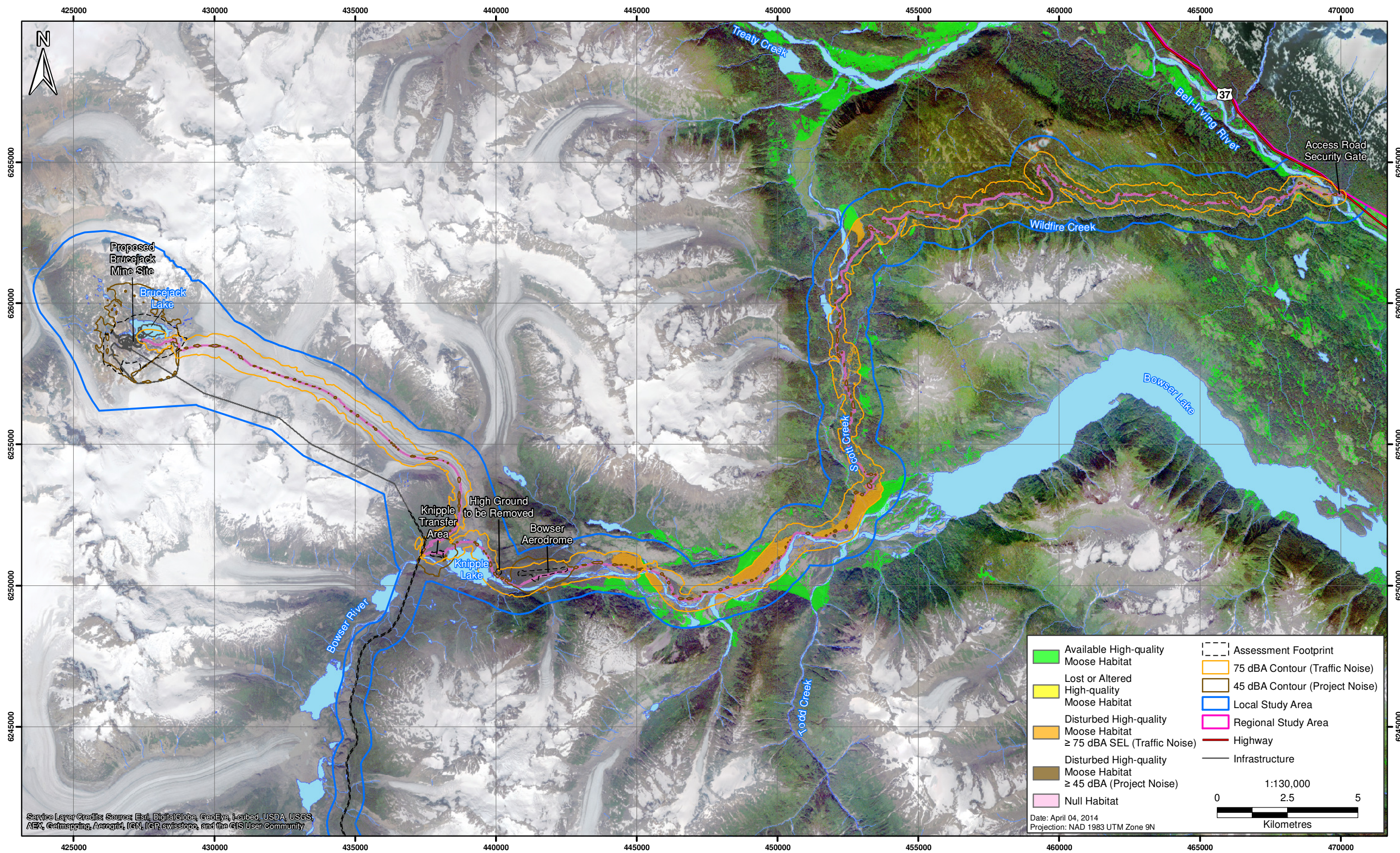


Figure 18.6-3  
 Functional Loss of High Quality Habitat for Moose due to Noise – Operation



During the growing season (spring, summer, and fall), moose may frequent forest edge habitats, such as road verges, because they contain high-quality forage and provide easy movement. During the winter, access roads will require snow removal. Moose will preferentially use ploughed roads when the winter snowpack is deep. High snowbanks of 60 cm or more (Peek et al. 1982) can trap moose on access roads, putting them at greater risk of vehicle strikes. Even at relatively low traffic densities, increases in traffic are predicted to increase the number of moose mortality from vehicle strikes (Seiler 2005). For example, in Norway, moose vehicle collisions increased from 0.07 moose per 10 km of road in 1977 to 0.19 moose per 10 km of road in 2007, while traffic increased by 1.9 times during the same time period (Rolandsen et al. 2011).

Vehicle-moose collisions occur throughout the species range and are highlighted as a problem from both wildlife management and traffic safety perspectives (Sielecki 2004; R. V. Rea et al. 2006). Evidence suggests that vehicle-moose collisions are less severe when speed limits are below 70 km/hour (Lavsund and Sandergren 1991). Along highways in the Bulkley-Stikine District (District 10, which includes Highways 16, 35, 37, 37A, and 118 and is approximately 201,700 km<sup>2</sup> in size), moose were the most commonly recorded road accident between 1988 and 2007 (1,022 moose collisions). This represents 38% of all wildlife collision, and an average of approximately 51 moose/year in the entire Bulkley-Stikine District (Sielecki 2010).

Within the Bulkley-Stikine District, the WARS database is subdivided into highway LKI segments. As mentioned previously, these data may under-represent the actual number of wildlife collisions, mainly due to reporting error; they are the best available data, but numbers must be interpreted with caution. The portion of Highway 37 that is adjacent to the RSA is included in approximately 65 km of LKI segment 3730 (69% of the LKI segment that is 93.53 km). Wildlife accidents in LKI segment 3730 along Highway 37 between 1993 and 2012 consisted primarily of moose (N = 32; average 1.6 moose/year), the majority (N = 14; 44%) of which occurred in January (BC MOTI 2011b).

It is estimated that the wildlife collision numbers recorded by the WARS system may only represent 25% to 35% of the actual number of animals killed on roads (Sielecki 2010); therefore, the number of vehicle collisions could be higher than reported by the WARS data. The average number of vehicle-moose collisions per year along Highway 37 within the LKI segment is 1.6. Based on the estimate that the data are under-reported by approximately 70%, the number of vehicle-moose collisions along LKI segment 3730 of Highway 37 could in fact be 5.3 per year. The LKI segment is 93.53 km; therefore, this could equate to approximately 0.017 vehicle-moose collisions per km of road (using 1.6 collisions per year), or, when inflating the numbers based on the estimated error in the WARS data, 0.057 vehicle-moose collisions per km of road.

Traffic along the 75 km access road could result in 1.3 vehicle-moose collisions per year, assuming 0.017 vehicle-moose collisions per km of road, or could be 4.3 vehicle-moose collisions per year if the numbers are inflated to account for error in the WARS data. However, the rate of vehicle-moose collisions is heavily dependent on the speed of vehicles involved, with mortality rate increasing above 70 km/hour (Seiler 2005). Hence, vehicle-related mortality along the access road is expected to be lower per km than on Highway 37. The rate at which mortality decreases between 90 km/hour and 70 km/hour is approximately 80% (Seiler 2005), which is similar but slightly greater than the estimated under-reporting of the WARS data (approximately 70% under-reported); therefore, it is assumed for this assessment that traffic along the access road with speed limits of less than 70 km/hour may result in 1.3 vehicle-moose collisions per year.

### Residual Effects for Moose due to Direct Mortality

Direct mortality from vehicle-moose collisions is predicted to result in a residual effect on moose. The highest potential for vehicle-moose interactions will be along the access road during the winter, because of the high density of moose in these areas. This effect may be magnified by moose using the ploughed access road as a movement corridor during the winter, thus increasing the chances of a vehicle-moose collision. Vegetation regrowth on roadsides and the ROW will also attract moose and increase the collision risk during the summer.

The potential effects of vehicle-related moose mortality will be mitigated by adherence to a Wildlife Management and Monitoring Plan (Section 29.21) and Transportation and Access Management Plan (Section 29.16). Mitigation along the access road will include at 40 km/hour speed limit, which will greatly reduce moose mortality as vehicles will be able to yield to wildlife observed on roadways. Other mitigation measures will include creating breaks in snowbanks along the ploughed roads (e.g., run outs at corners of the road) and providing signage in high-value wildlife areas or known wildlife travel corridors. In addition, vegetation will be kept low along the access roads to ensure drivers see wildlife along the sides of the roads, if they are present (McElhanney 2011). After mitigation, it is anticipated that vehicle-moose collisions may still occur, resulting in direct mortality due to increased traffic; therefore, residual effects of direct mortality on moose are anticipated along the access road.

#### *18.6.1.6 Indirect Mortality*

The potential source of indirect mortality identified for moose in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area. Access management is a concern throughout the relevant land management plans (i.e., Nass South SRMP and CIS LRMP). The segment of road from Browser Lake to the Knipple Glacier was rehabilitated and new access was created from the construction of the road from Highway 37 to the west end of Browser Lake.

The Project will increase access to some moose winter range habitats along the Brucejack Access Road, into the high-quality moose habitat identified along the Bowser River and the Todedada wetland complex, including portions of moose UWR u-6-018 near Bowser Lake. During construction of the transmission line the existing Granduc Access road that is located in moderately high-quality habitat along the southern branch of the Bowser River, will be used. The Brucejack Access Road will also likely attract moose for easier movement (snow conditions) and forage production from the ROW, which will increase their vulnerability to harvest.

Road creation in high-quality moose habitat, particularly when roads are cleared in the winter, could also increase predator access (e.g., wolves) into areas occupied by moose. This could, in turn, increase predator-induced mortality of moose. Wolves tend to avoid roads with human activity (Kunkel and Pletscher 2000); therefore, the effect of indirect mortality due to wolf predation as a result of increased access along the access road would not be an effect during Project activities (i.e., construction, operation, closure). During the Post-closure phase, with the decrease in activity levels, wolves could use the access road as a movement corridor; however, because the road will be deactivated and re-vegetated, the effect of indirect mortality due to increased wolf predation is not considered to be a residual effect.

Moose populations and hunting are regionally and provincially managed in BC by the BC MFLNRO through the quotas set for both non-Aboriginal resident trophy and subsistence hunters and through conservation enforcement.

A portion of the wildlife RSA overlaps the NWA at the southernmost point of the RSA. Nisga'a hunters in Nisga'a lands and the NWA are regulated by annual allocations set by a joint management committee

composed of the Province, the Government of Canada, and Nisga'a Lisims Government. Despite the regulated nature of these hunts, an increase in access to high-quality moose habitats could increase unregulated moose hunting (illegal hunting and Aboriginal hunting) and negatively affect local moose populations, as moose populations are sensitive to unregulated harvest (Blood 2000a). Increases in access for unregulated hunting may also increase the hunting of female moose, which can have greater population consequences than regulated hunting of males during the fall.

#### Residual Effects for Moose due to Indirect Mortality

The effect of indirect mortality is predicted to result in a residual effect on moose. The access road and transmission line ROW could increase hunting pressure on moose in the RSA. To reduce or eliminate this effect, the Brucejack Access Road will be gated, staffed, and controlled at Highway 37, reducing the possibility of unauthorized vehicle access into the area. Project employees and contractors will be prohibited from bringing personal firearms and weapons to work (Section 29.21, Wildlife Management and Monitoring Plan). Areas of previously inaccessible high-quality moose habitat will, nevertheless, become accessible. Increased access cannot be completely avoided or mitigated, thus a potential adverse residual effect is predicted for moose.

#### *18.6.1.7 Attractants*

Moose may be attracted to the Project via three potential attractants: 1) road salts acting as artificial mineral licks; 2) the roadside vegetation attracting moose as forage; and 3) the road corridor attracting moose in the winter as a movement corridor due to ease of movement.

#### Road Salts

Natural mineral licks are important habitat features for ungulates, as they provide dietary minerals (Klaus and Schmid 1998; Ayotte, Parker, and Gillingham 2008). Moose primarily use mineral licks in early spring (Couturier and Barrette 1988) and potentially in early winter (R.V. Rea, Hodder, and Child 2004). Animals may travel considerable distances to reach mineral licks, with records of moose travelling up to 7 km (Risenhoover and Peterson 1986). Because ungulates are attracted to sources of minerals and salt, road salts often attract moose to roads where they can be at risk of vehicle-related mortality. Road salts are attractive during the winter and during summer when the salts have dissolved into downslope receiving environment (e.g., ponds or wetlands adjacent to the road; Fraser and Thomas 1982; Environment Canada and Health Canada 2001).

The road maintenance planned for the Project does not include the use of road salts along the Brucejack Access Road. Therefore, salts along the road are not considered a potential attractant for moose.

#### Movement Corridor

Closed roads or roads with little traffic are also frequently used as travel routes by ungulates. Moose are therefore likely to use the access road to reach suitable habitats near Bowser River and Todedada wetlands, particularly during winter, when the road is ploughed and the snow pack hampers movement elsewhere. The attraction and use of the access road by moose will increase the risk of vehicle/moose interactions. The Wildlife Management and Monitoring Plan (Section 29.21) will guide mitigation of the potential for moose mortality along access roads and mine site roads (Section 18.6.1.5).

#### Residual Effects for Moose due to Attractants

To mitigate the effects of attractants for moose, salts will not be used along the access road. In addition, mitigation will include creating breaks in snowbanks along ploughed roads and following other

mitigation practices to minimize indirect mortality (Section 18.6.1.6) and direct mortality (Section 18.6.1.5). After mitigation, no residual effect of attractants is expected for moose.

No additional sources of COPCs were identified for moose, thus the effects of chemical hazards in moose are not considered further.

### 18.6.2 Potential Residual Effects on Mountain Goats

#### 18.6.2.1 Identifying Key Effects

Mountain goats were assessed for potential Project-related effects. Habitat loss and alteration, sensory disturbance, disruption of movement, direct mortality, indirect mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on mountain goat populations. There were no effects scoped out for mountain goats. The potential residual effects considered in the assessment for mountain goats are summarized in Table 18.6-3 and described in the following sections, from Section 18.6.2.2 to 18.6.2.8.

**Table 18.6-3. Ranking Potential Effects on Mountain Goats**

Project Components/ Physical Activities	Potential Effects on Mountain Goats						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/Browser Aerodrome	●	●	●	●	●	●	○
Access Road	○	●	●	●	●	●	○
Transmission Line	●	●	●	●	●	●	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/Browser Aerodrome	●	●	●	●	●	●	○
Access Road	○	●	●	●	●	●	○
Transmission Line	●	●	●	●	●	●	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/Browser Aerodrome	○	●	●	●	●	●	○
Access Road	○	●	●	●	●	●	○
Transmission Line	○	●	●	●	●	●	○

**Notes:**

- = No interaction expected; no monitoring required, no further consideration warranted.
- = No interaction or negligible adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.
- = Potential minor to moderate adverse effect that may require unique active management/monitoring/mitigation; warrants further consideration.
- = Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.

### 18.6.2.2 *Habitat Loss and Alteration*

The assessment of habitat loss and alteration for mountain goats due to the Project focuses on the loss and alteration of winter and summer habitat. Project infrastructure and facilities that overlap high-quality mountain goat habitat primarily includes the Brucejack Mine Site and Brucejack Transmission Line. Mountain goats have large home ranges and use a variety of elevations and habitat types between seasons. Winter habitat is generally considered to limit the number of mountain goats that can be supported by a land base. Metabolic demands increase in winter because of the effort required to move through deep snow packs and tolerate colder weather (Safford 2004a), and this occurs during a season where forage has a lower nutritional value. The quality and quantity of forage available in winter influences how quickly summer fat reserves are depleted, thereby affecting changes of survival and reproduction (BC MELP 2000).

Conservation of ungulate winter range for goats is an objective of the land and resource management plans associated with the LSA and RSA for these reasons (i.e., Nass South SRMP, CIS LRMP). Loss and alteration of mountain goat UWR u-6-002 in the RSA was also assessed. The mountain goat assessment includes an evaluation of summer habitat loss and alteration because mountain goats are also susceptible to disturbance during the kidding season in spring and summer, and since kidding habitat requires very specific and limited topographic features.

High and Moderately High suitability habitat (HSR 1 and 2) from habitat suitability modelling ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report) is hereafter referred to collectively as “high-quality habitat” for mountain goat.

#### Mountain Goat Habitat Requirements and Availability

Habitat selection by mountain goats is largely driven by topographical features. Steep escape terrain (i.e., cliff habitat) is a critical factor that drives selection of both summer and winter goat habitats (Herbert and Turnbull 1977). High-quality habitats are areas close to escape terrain that support high-quality forage, such as shrubs, herbs, and krumholtz. Summer habitats tend to be vegetated areas near escape terrain above the treeline on south- and west-facing slopes. Winter habitats tend to be similar areas, but downslope, below the treeline. Within the RSA, 98,042 and 93,578 ha of high-quality winter and summer habitat, respectively, were identified through habitat suitability mapping.

Within the LSA, 3,160 and 4,041 ha of high-quality winter and summer habitat, respectively, were identified (excluding 341 ha of previously disturbed habitat along the access road within the LSA). In addition, 19,364 ha of UWR u-6-002 occurs within the RSA, 14,649 ha (76%) of which overlaps with the high-quality winter habitat mapped using habitat suitability mapping. Of the 19,364 ha of UWR in the RSA, 542 ha (2.8%) falls within the LSA.

#### Mountain Goat Habitat Loss and Alteration

**Winter Habitat:** Habitat mapping identified 98,042 ha of high-quality winter habitat for mountain goats in the RSA (Table 18.6-4). Of this area, 110 ha (0.1% of the RSA, 3.5% of the LSA) will be lost or altered (i.e., Project footprint and buffers) as a result of Project development (Figures 18.6-4 and 18.6-5). Most of this loss and alteration (95 ha, 86%) is due to development of the Brucejack Mine Site (i.e., within the Brucejack Mite Site assessment footprint), and the remaining 15 ha are due to construction of the transmission line (Figure 18.6-5), both of which are at high elevation. The access road and aerodrome are at lower elevations, outside of goat winter or summer habitat.

**Table 18.6-4. Mountain Goat Habitat Loss and Alteration due to the Project**

Season	Habitat Lost and Altered (ha)	RSA		LSA	
		Total Habitat <sup>1</sup> (ha)	Habitat Lost/ Altered (%)	Total Habitat <sup>1</sup> (ha)	Habitat Lost/ Altered (%)
Winter	110	98,042	0.1	3,160	3.5
Summer	113	93,578	0.1	4,041	2.8
Total Winter and Summer	138	117,955	0.1	4,549	3
UWR	1.6 <sup>2</sup>	19,364	0.008	542	0.3

<sup>1</sup> Total habitat refers to high-quality habitat in the RSA and LSA; see text for definition of high-quality habitat.

<sup>2</sup> 1.3 ha of the lost or altered UWR overlaps with the high-quality winter habitat already accounted for in the 110 ha of winter habitat lost or altered.

A total of 1.6 ha (0.008%) of the 19,364 ha of UWR u-6-002 within the RSA will be lost or altered during the Operation phase (Figures 18.6-5a, 18.6-5b), 1.3 ha of which is also considered high-quality winter habitat based on suitability models. To avoid double counting the area of winter habitat from the models that overlap with the UWR, this leaves an additional 0.3 ha of UWR (near the transmission line) that was not already considered lost based on the habitat suitability model calculations.

**Summer Habitat:** In the RSA, 93,578 ha of high-quality summer habitat was identified for mountain goats (Table 18.6.4). Of this area, 113 ha (0.1% of the RSA, 2.8% of the LSA) will be lost or altered (i.e., Project footprint and buffers) as a result of Project development (Figures 18.6-6a and 18.6-6b). Of this area, 73.4 ha (65%) is due to the development of the Brucejack Mine Site (plus an additional 1 ha of high ground to be removed), and 38.2 ha is due to construction of the transmission line.

#### Residual Effects for Mountain Goats due to Habitat Loss and Alteration

The effect of direct habitat loss and alteration is not predicted to result in a residual effect on mountain goats. During the winter, mean mountain goat home range size is approximately 140 ha for females and 271 ha for males (Taylor, Wall, and Kulis 2006), but can be as small as 20 ha (Fox, Smith, and Schoen 1989); therefore, the loss and alteration of winter habitat from habitat suitability modelling and the UWR associated with the Project (138 ha) could be equivalent to a maximum of 6.9 home ranges, or as little as half of a home range (average 3.7 home ranges). The average mountain goat density during summer was 0.26 goats per km<sup>2</sup> (0.0026 goats per hectare); therefore the loss of 113 ha of summer habitat may affect 0.3 goats. Therefore, no residual effect on mountain goats is predicted for habitat loss and alteration due to the Project.

#### *18.6.2.3 Sensory Disturbance*

The various sources of sensory disturbance (noise and visual) may act together to result in functional habitat loss due to avoidance of high-quality habitats because of disturbance. Mammal density has been shown to decrease up to 5 km away from industrial projects, and avoidance distances are greater in open versus forested habitats (Benitez-Lopez, Alkemade, and Verweij 2010). Industrial activity can cause disturbance to wildlife that varies from short term (e.g., increased vigilance and short flight response) to long term. Long-term chronic disturbance of ungulates can have several effects, including displacement of individuals or groups, earlier-than-usual migration, or changes in rates of movement (Van Dyke and Klein 1996). Mountain goats appear to react to human disturbance to a higher degree than most ungulates (BC MOE 2010b).

Figure 18.6-4  
Mountain Goat Winter Habitat Lost or Altered due to the Project

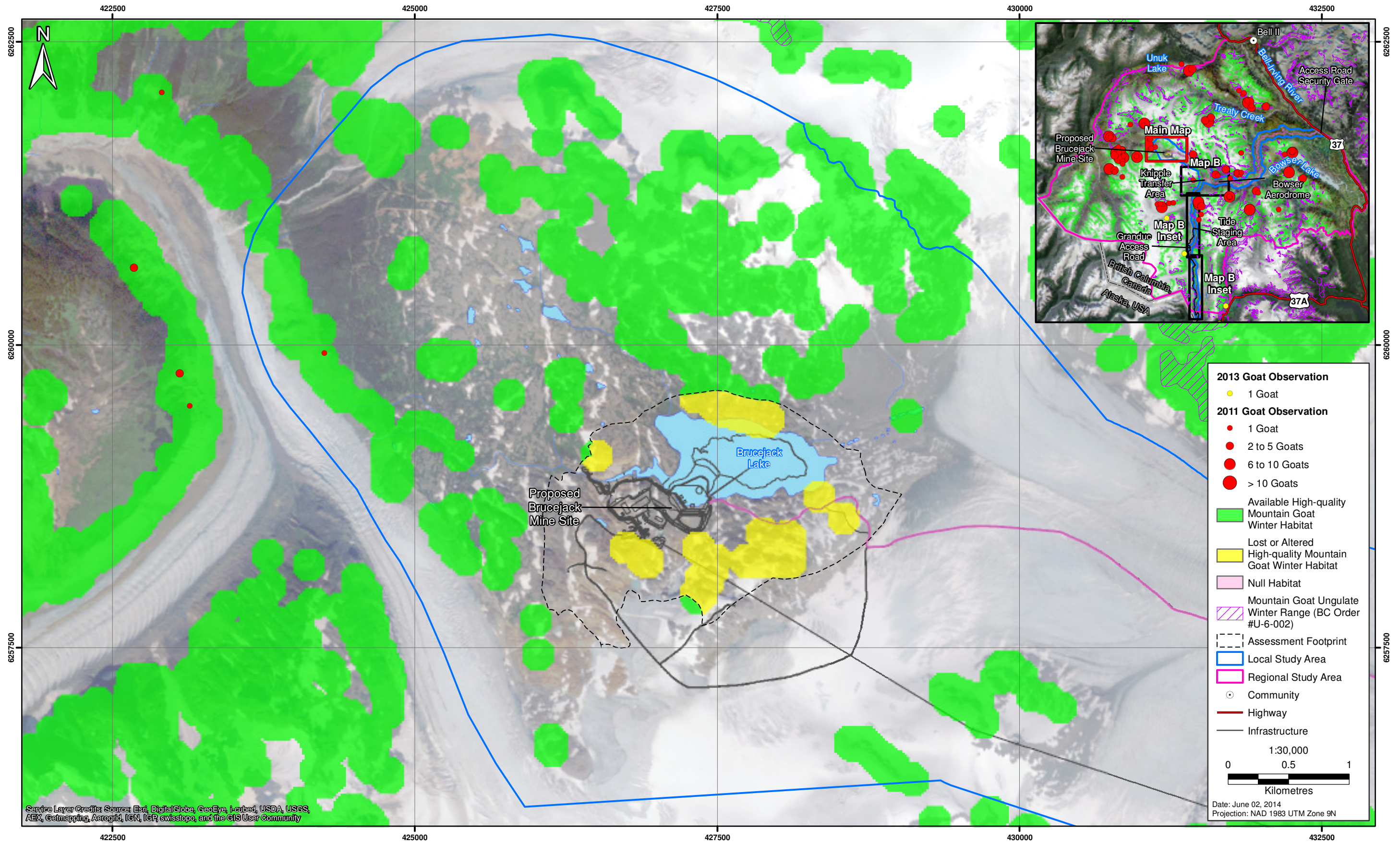


Figure 18.6-5  
Mountain Goat Winter Habitat Lost or Altered due to the Project

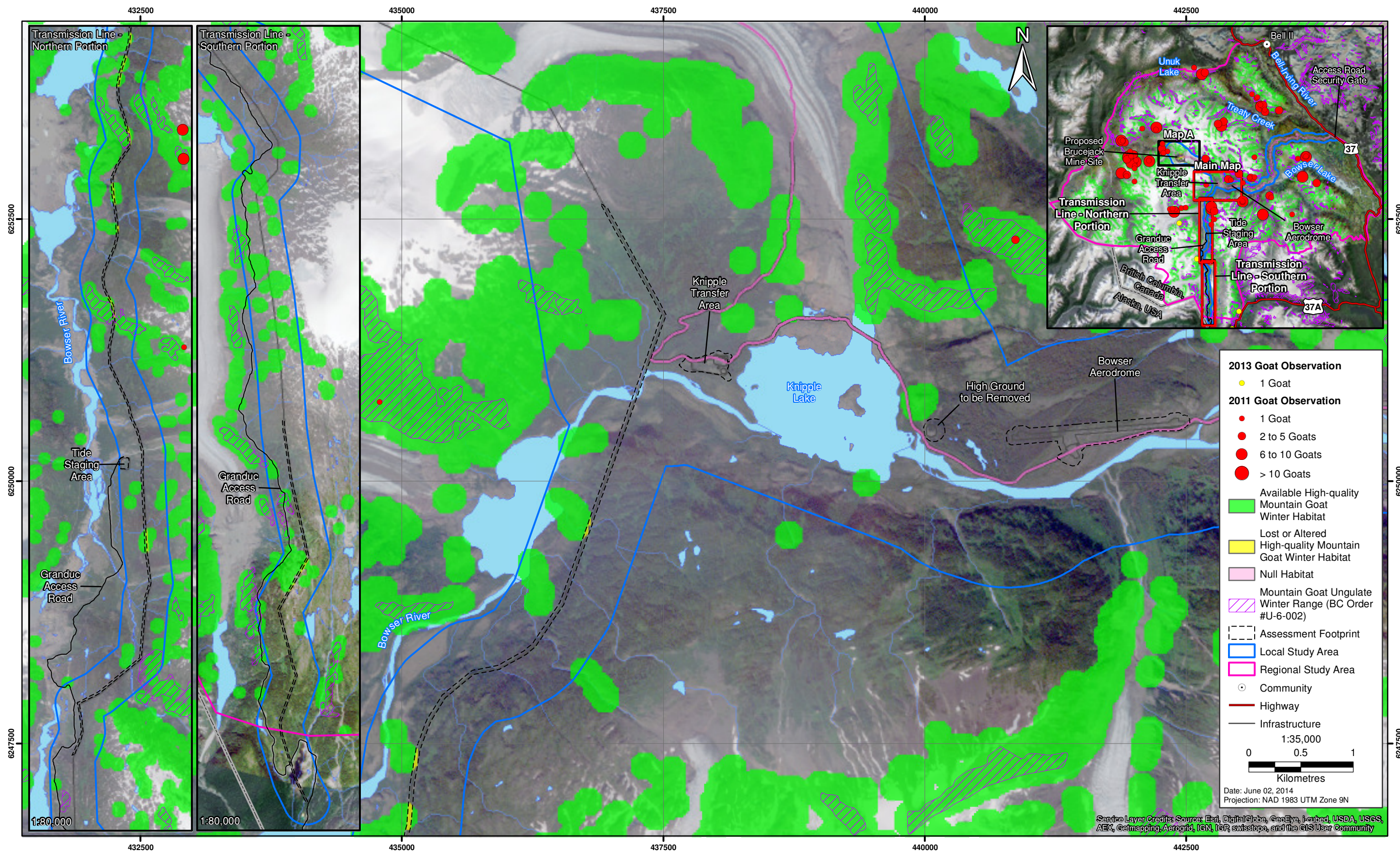


Figure 18.6-6a  
 Mountain Goat Summer Habitat Lost or Altered due to the Project

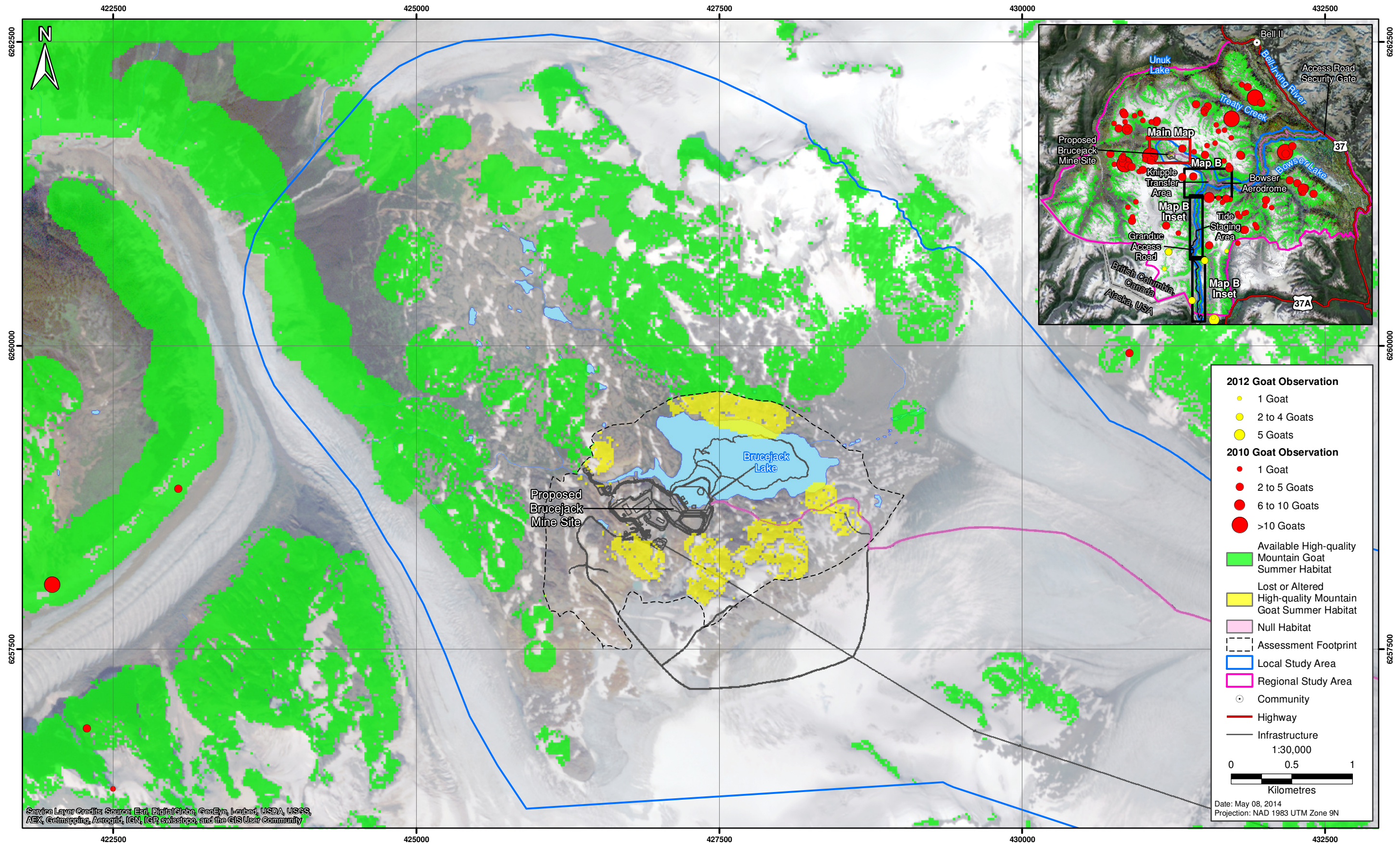
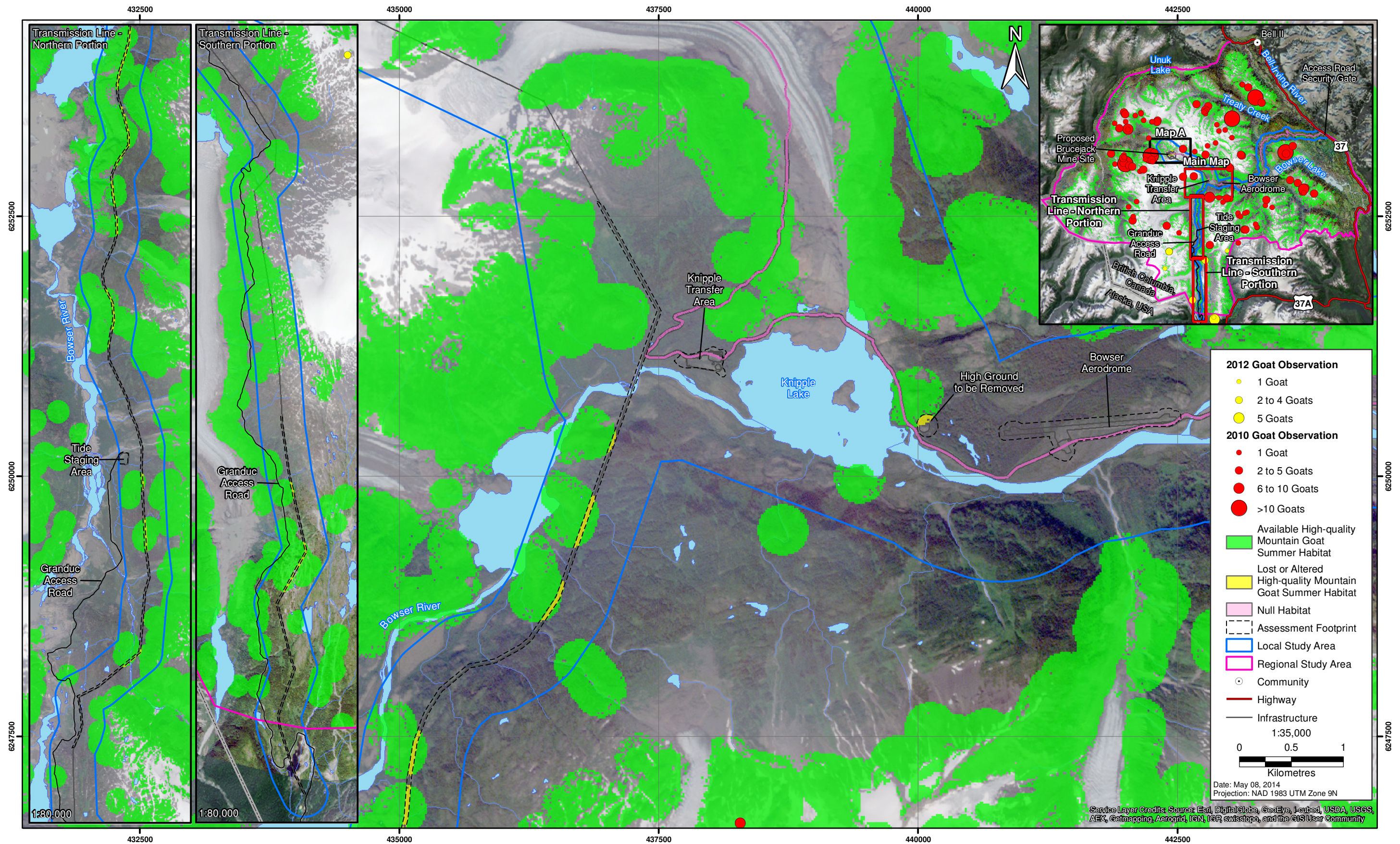


Figure 18.6-6b  
 Mountain Goat Summer Habitat Lost or Altered due to the Project



Potential sources of sensory disturbance for mountain goats associated with the Project include: 1) elevated Project noise levels; 2) increased aircraft and traffic volumes; and 3) blasting. Mountain goats are known to be sensitive to disturbance from human activity; studies have been carried out on the effects of noise, such as aircraft noise particularly from helicopters, on mountain goats (Côté 1996; Goldstein et al. 2005). Goats have been observed responding to helicopter noise up to 2 km away (Côté 1996; BC MOE 2010b; Cadsand 2012). On the other hand, some studies have suggested that mountain goats can habituate to disturbances associated with oil and gas development (Wilson and Shackleton 2001), but sudden and novel events continue to evoke startle reactions. Other studies, however, have found no evidence of habituation, and have found that goats become more sensitive over time with continued noise exposure (Foster and Rahe 1983; Côté 1996; Gordon and Wilson 2004).

Mountain goats may also be displaced from preferred habitat, or they may return after the disturbance is removed. For example, in northern BC, mountain goats were observed to abandon an area that was within 3 km of mining disturbances (helicopters, drilling, noise), but returned after the disturbance was removed (Foster and Rahe 1983; Gordon and Wilson 2004).

Noise modelling was completed to determine the area of mountain goat summer and winter habitat that may be functionally lost or disturbed due to sensory disturbance during Construction and Operation and due to instantaneous noise from helicopter and fixed-wing aircraft overflights and blasting. The total area of High and Moderately High suitability (high-quality) winter and summer habitat that falls outside of the area of direct habitat lost due to the Project footprint (Section 18.6.2.2), but within the noise level contours of 45 dBA (Project noise), 75 dBA LAE (traffic noise), 80 dBA LAE (helicopter and aircraft noise), 108 dB Lpeak (disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response), and 120 dB Lpeak (functionally lost habitat from instantaneous blasting noise, resulting in abandonment of habitat) or greater was calculated.

#### *Project Noise*

The total amount of high-quality summer and winter habitat affected by elevated Project noise levels (outside of the area already considered to be lost in Section 18.6.2.2) during Construction is 602 ha (Figure 18.6-7), and 152 ha during Operation (Figure 18.6-8). The majority of sensory disturbance will be associated with the site development (Brucejack Mine Site and Knipple Transfer Area) during Construction (390 ha) and Operation (125 ha).

#### *Traffic Noise*

The total amount of high-quality habitat affected by elevated traffic noise levels during Operation (i.e., worst case scenario) is 391 ha (0.3% of the available habitat in the RSA). The majority of this traffic noise is associated with traffic travelling along the access road between Highway 37 and the aerodrome (286 ha) and between the Knipple transfer facility and the aerodrome (104 ha).

#### *Helicopter and Aircraft Noise*

The Province of BC provides guidance on helicopter activities in and near goat habitat (Management Plan for the Mountain Goat in British Columbia; BC MOE 2010b). The current guidelines state that helicopters should avoid flying within a 2-km buffer either horizontally or vertically from mountain goat habitat. Previous guidelines indicated a 1.5-km buffer during winter (November 1 to April 30) and kidding season (May 1 to July 15) and 1.0 km for the summer and fall periods. At the Project site, travel through a series of narrow valleys is necessary where the total width of the valley is 1.5 to 2 km, preventing helicopters from maintaining the 2 km horizontal buffer distance. In some cases, the coastal-influenced area of the RSA, including the Brucejack Mine Site, experiences low cloud which forces helicopters down into the valleys and prevents them from maintaining a 2-km vertical buffer from mountain goat habitat.

This scenario, where topography and weather often force helicopters into the 2-km suggested buffer around goat habitat, is considered the worst-case scenario for helicopter noise at the Project.

Fixed-wing aircraft will be landing at the aerodrome and will also result in noise disturbance to goats. The worst-case scenario of both helicopter and fixed-wing aircraft noise was modelled for the effects assessment to evaluate the potential effects of noise on mountain goats during the Operation phase, when both helicopters and fixed-wing aircraft will be used.

Noise from both types of aircraft overflights (using the worst-case scenario) at 80 dBA LAE will result in an area of 8,715 ha (61% of high-quality habitat in the LSA and 7% in the RSA) where goats may be disturbed in high-quality habitat during Operation (outside of the area already considered to be lost in Section 18.6.2.2). Under better weather conditions than the worst-case scenario, this area is reduced substantially. A total of 5,868 ha of habitat will be functionally lost due to helicopter noise with the majority (4,132 ha) of sensory disturbance due to helicopters associated with flight paths outside of the wildlife LSA, the flight path along the Brucejack Transmission Line (583 ha), and near the Brucejack Mine Site (563 ha; Figure 18.6-8). The majority of disturbance due to fixed-wing aircraft will be along the flight paths into the airstrip (Figure 18.6-9).

During Construction, helicopters will be the only source of aircraft noise, as fixed-wing aircraft will not be flying in and out of the Project area. Helicopters will be used during the Construction phase which is estimated to last for two years (Section 18.4.2.2). During Construction, noise from helicopters at 80 dBA will result in an area of 5,868 ha (37% of high-quality habitat in the LSA and 5% of the RSA) where goats may be disturbed (outside of the area already considered to be lost in Section 18.6.2.2). The majority (4,132 ha) will occur along assumed flight paths following the access road/lower Bowser valley, or the upper Bowser valley following the transmission line alignment (Figure 18.6-9). During Operation, helicopters will still be used but on an emergency basis, i.e. infrequently.

#### *Blasting Noise*

During Construction, noise from blasting near the Brucejack Mine Site will result in disturbance to goats in 0.6 ha of habitat (108 dB), and no functional loss (120 dB) of high-quality summer and winter habitat (Figures 18.6-7 and 18.6-8). This area is small because most of the blasting will be occurring underground and effectively muffled as a consequence. The area of high-quality habitat that may be disturbed due to blasting (108 dB) is 0.01% of the available habitat in the LSA, and is therefore not considered further in the assessment.

#### Residual Effects for Mountain Goats due to Sensory Disturbance

The effect of sensory disturbance is predicted to result in a residual effect on mountain goats due to helicopter and fixed-wing aircraft noise. While some of the sources of disturbance can be mitigated (e.g., helicopter flight paths), noise effects are still expected, due to potential weather restrictions and the location of the Bowser Aerodrome (i.e., goat habitat on either side of the valley). When considering the number of goats observed during baseline surveys, the estimated density in the winter is approximately 0.24 goats/km<sup>2</sup> (235 individuals within 980 km<sup>2</sup> of high-quality winter habitat) and 0.26 goats/km<sup>2</sup> (243 individuals within 936 km<sup>2</sup> of high-quality summer habitat) in the summer. The amount of winter and summer habitat that may be disturbed due to helicopter and aircraft noise is approximately 87 km<sup>2</sup>, resulting in disturbance to approximately 20 (8.5% of the number of goats observed during winter) to 23 (9.5% of the number of goats observed during summer) goats. The noise disturbance will be short in duration (e.g., potential less than one aircraft flight per month during Operation); however, due to mountain goat sensitivity to aircraft and helicopter noise disturbance and despite mitigation, the effect of sensory disturbance on mountain goats is predicted to result in a residual effect.

Figure 18.6-7  
 Functional Loss of High-quality Habitat for Mountain Goats due to Noise – Construction

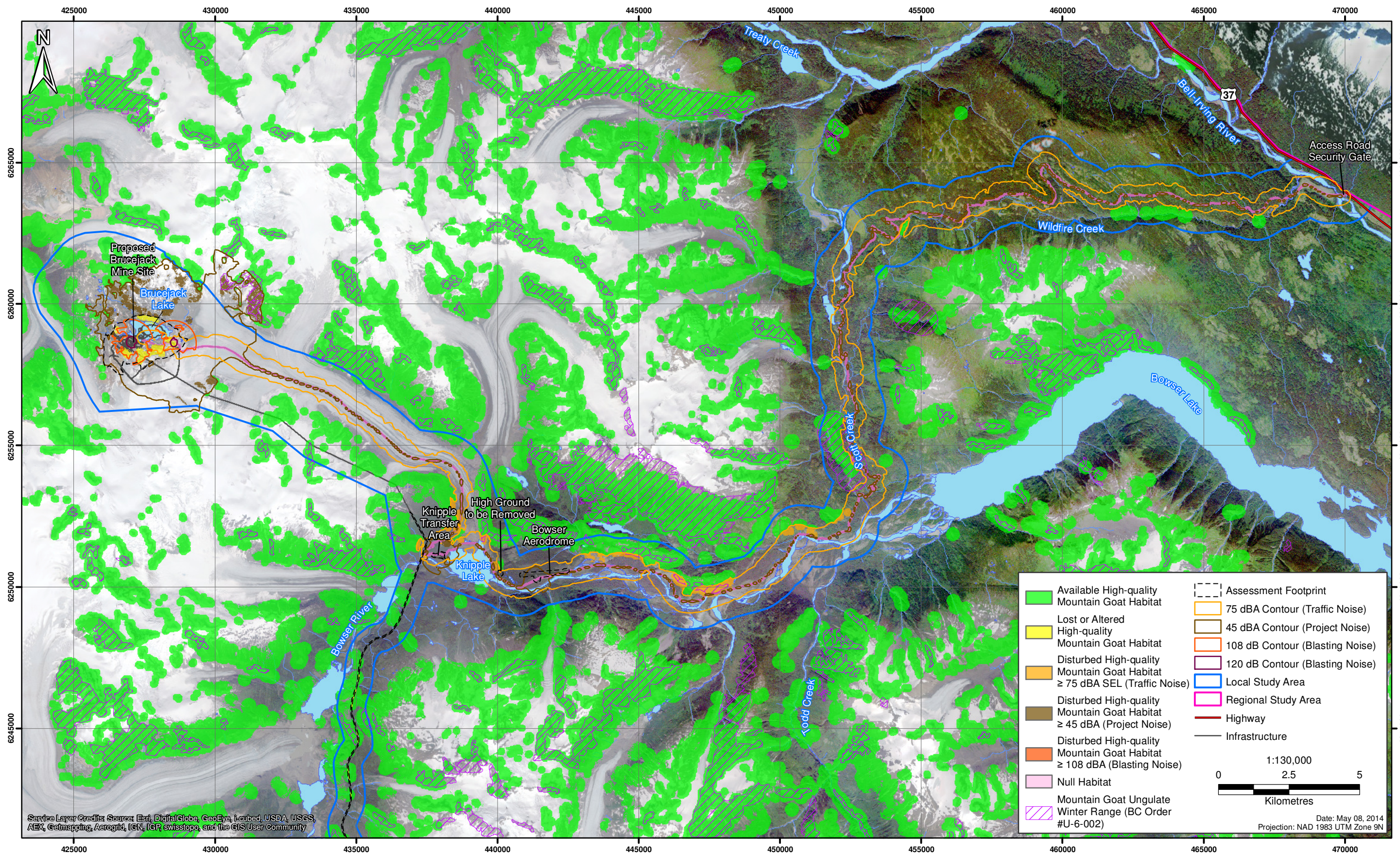


Figure 18.6-8  
 Functional Loss of High-quality Habitat for Mountain Goats due to Noise – Operation

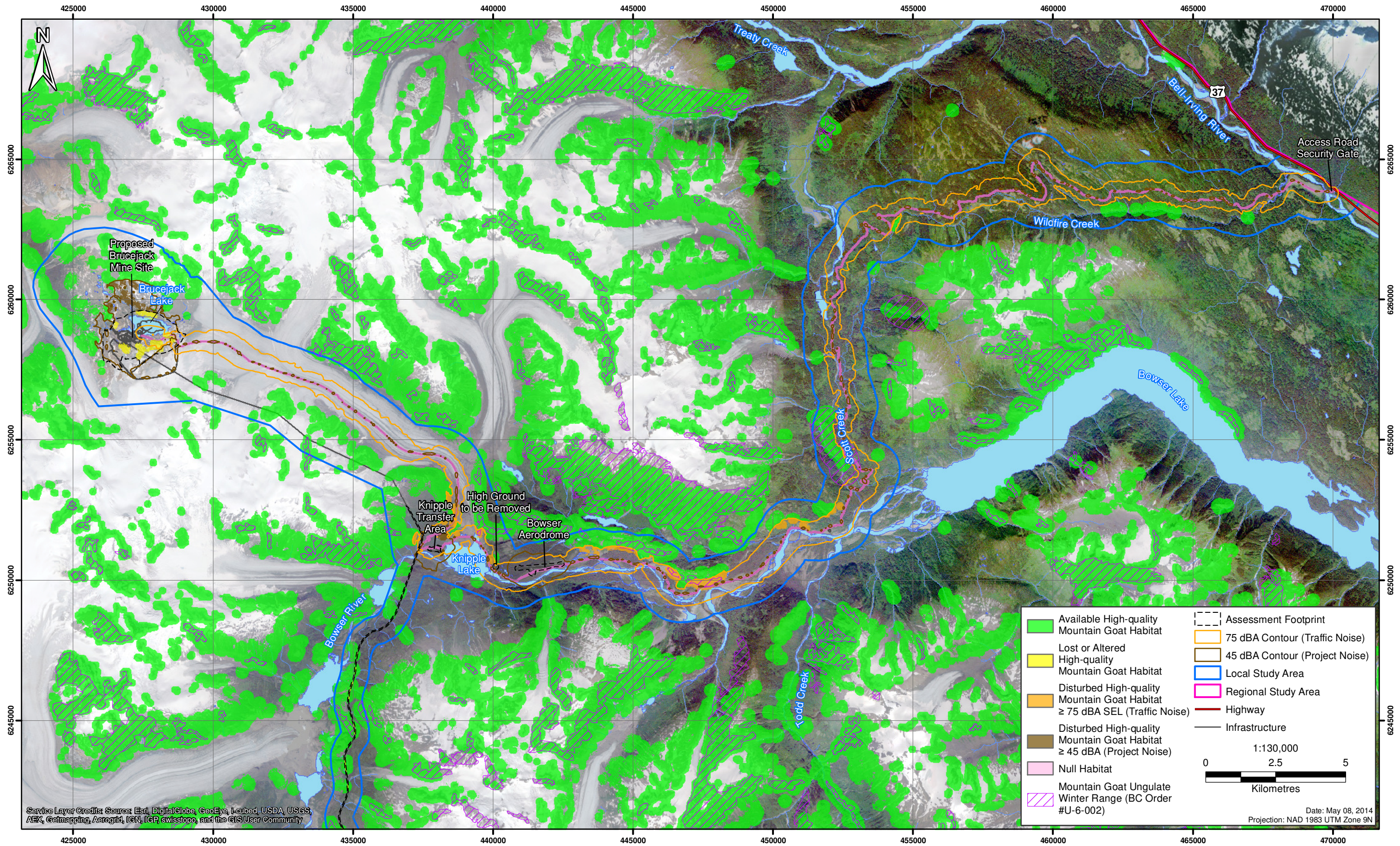
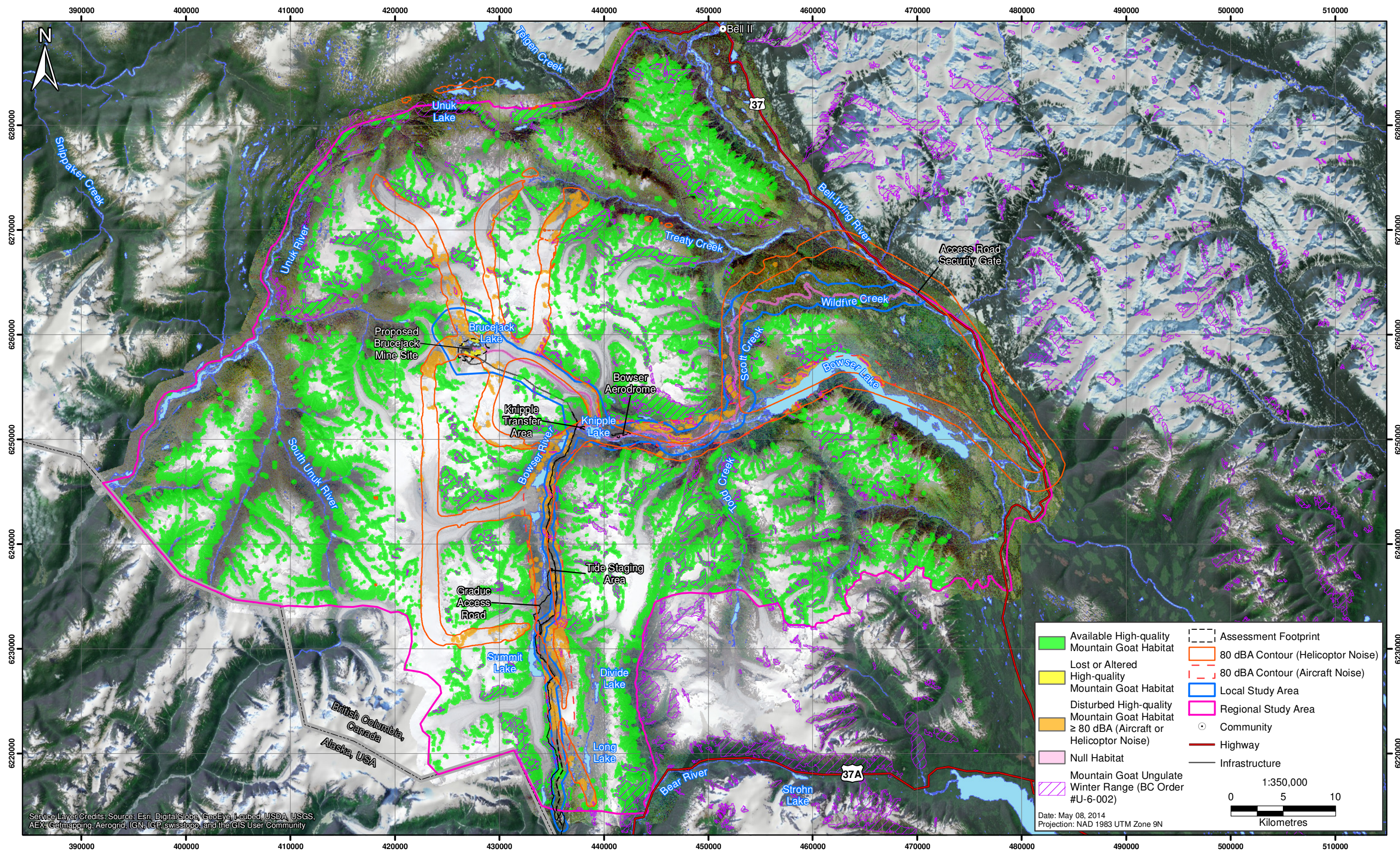


Figure 18.6-9  
 Functional Loss of High-quality Habitat for Mountain Goats due to Noise - Aircraft and Helicopter



#### 18.6.2.4 *Disruption of Movement*

Mountain goats maintain separate seasonal habitats and movements between and within habitats, which are typically infrequent and short in distance (Côté and Festa-Bianchet 2003). Because occupied goat habitat is strongly associated with escape terrain and favourable aspects (south and west), summer and winter habitats often overlap spatially, which limits the need for extensive movements. Longer movements do occur, however, when mountain goats move between isolated patches of suitable habitat. In addition, goats may travel long distances to access mineral licks (Côté and Festa-Bianchet 2003).

Mountain goats tend to use ridge tops to move between seasonal habitats and between suitable habitats within a particular season. Mountain goats are also known to use traditional trails to move between seasonal ranges (Wilson 2005). Disruption of movement may result from development of infrastructure at high elevation. As mountain goats tend to travel along ridge tops and the access road is primarily located in valleys, it is unlikely that the access road will affect mountain goat movement patterns.

Most suitable mountain goat habitat and established UWR in the LSA occur at high elevation, but there is minimal infrastructure overlapping or near these areas. Some disruption of movement may occur as a result of development of this area. Helicopter flight noise associated with various aspects of mine construction and operation may also act as a barrier to movement (see Section 18.7.3, Sensory Disturbance).

Mountain goats are sensitive to helicopter disturbance and may avoid areas up to 2 km from helicopter traffic (BC MOE 2010b; Cadsand 2012). As a result, disruption of movement may occur if goats are unwilling to cross areas with frequent helicopter traffic (Section 18.6.2.4; Figures 18.6-7, 18.6-8, and 18.6-9).

#### Residual Effects for Mountain Goats due to Disruption of Movement

Reclamation in the Brucejack Mine Site may result in no long term effect related to disruption of mountain goat movement. Management of helicopter flight plans to avoid mountain goat habitat (Section 29.21, Wildlife Management and Monitoring Plan) will also reduce disruption of mountain goat movement. With mitigation, the effect of disruption of movement is not predicted to result in a residual effect on mountain goats.

#### 18.6.2.5 *Direct Mortality*

There are two sources of direct mortality that may affect mountain goats: vehicle collisions and mortality associated with avalanche control. These two sources of mortality are discussed in the following section.

##### *Vehicle Collisions*

In contrast with moose, there is little likelihood of vehicle-related mortality for mountain goats on Project roads. The primary transportation corridor (i.e. Brucejack Access Road) is largely located at elevations below suitable goat habitat, thereby limiting the possibility of goats being present on or near the access road. Mountain goat sensitivity to disturbance may also ensure that they remain a safe distance away from transportation and development infrastructure. This assessment is supported by the absence of reported vehicle incidents involving mountain goats along highways in the Bulkley-Stikine District from 1983 to 2007 (Sielecki 2004, 2010).

However, goats may be at risk of vehicle collisions in areas where proposed roads are located at high elevation near, within, or between suitable goat habitats, such as high-quality summer and winter habitats, within provincially-designated UWR, or along traditional trails to mineral licks. These areas include the area along the access road from the Knipple Transfer Area to the Brucejack Mine Site.

### *Avalanche Control*

During winter, mountain goats occupy habitat in or below areas prone to avalanches, including alpine areas above the access road (see areas AR 1, 2, 4, 5, and 6 on Figure 5.14-2), and near Knipple Lake and along Knipple Glacier (see areas KG8 and southeast to AR7 and 8 on Figure 5.14-2). Although there are recorded historic accounts of mountain goat being killed in avalanches, it is not considered a frequent cause of mortality (e.g., Macgregor 1977; Chadwick 1983). Goats may also abandon habitat due to disturbance caused by avalanche control.

### Residual Effects for Mountain Goats due to Direct Mortality

The effect of direct mortality is not predicted to result in a residual effect on mountain goats. The potential effects of vehicle-related wildlife mortality will be mitigated for mountain goat by adherence to a Wildlife Management and Monitoring Plan (Section 29.21). Mitigation will include adherence to speed limits, yielding to wildlife observed on roadways, creating breaks in snowbanks along ploughed access roads, and providing signage in high-value wildlife areas or known wildlife travel corridors. In addition, the road maintenance planned for the Project does not include the use of road salts along the Brucejack Access Road and their acting as attractants will thus be avoided (Section 18.6.2.7).

Avalanche control may result in incidental mortality of mountain goats. Incidental observations of mountain goats during avalanche control procedures will be recorded whenever possible, to provide information on the locations of goats in relation to avalanche terrain. Mitigation measures can be implemented, such as delaying avalanche blasting until goats have moved out of the area, if safety to the Project and Project personnel is not being compromised. With mitigation, residual effects due to direct mortality are not anticipated for mountain goats.

#### *18.6.2.6 Indirect Mortality*

The potential sources of indirect mortality identified for mountain goat in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area. Mountain goats are very sensitive to overharvest (Blood 2000b; Festa-Bianchet and Côté 2007). The Brucejack Access Road and Brucejack Transmission Line may provide new access to alpine areas (particularly BAFA BEC zone) for goat hunters using ATVs and snowmobiles. Alpine areas along the transmission line contain high-quality winter and summer habitat, including established UWR (#U-6-002). The access road also puts mountain goat habitat within a 1 km hike of hunters during all seasons.

### Residual Effects for Mountain Goats due to Indirect Mortality

The effect of indirect mortality is predicted to result in a residual effect on mountain goats. Mitigation measures to reduce the effect of increased access to mountain goats will include controlling access to the Brucejack Access Road. The Brucejack Access Road will be gated and staffed, reducing the possibility of unauthorized access into the area. During Operation, the transmission line may provide easy access to snowmobile and ATV users into goat habitat. The transmission line will be decommissioned during Post-closure, and therefore vegetation will grow back along the ROW and access will become limited. Project employees and contractors will be prohibited from bringing personal firearms and weapons to work (Section 29.21, Wildlife Management and Monitoring Plan). The potential for indirect mortality as a consequence of increased hunting pressure may still occur due to creating access into BAFA habitat, particularly along the transmission line, thus a potential adverse residual effect is predicted for mountain goats.

#### *18.6.2.7 Attractants*

Natural mineral licks are important habitat features for ungulates, as they provide dietary minerals (Klaus and Schmid 1998; Ayotte, Parker, and Gillingham 2008). Ungulates are attracted to sources of

minerals and salt; therefore, road salts may attract goats to roads where they can be at risk of vehicle-related mortality.

The use of road salts for winter road ice management is a concern for mountain goats; however, the road maintenance planned for the Project does not include the use of road salts along the Brucejack Access Road. Therefore, salts along the road are not considered a potential attractant for mountain goats.

#### Residual Effects for Mountain Goats due to Attractants

To mitigate the effects of salts acting as an attractant for mountain goat, salts will not be used along the Project roads. After mitigation, no residual effect is expected for mountain goat.

#### *18.6.2.8 Chemical Hazards*

Chemical hazards to mountain goats were considered for the mine site area only as high-quality habitat for mountain goat in the access road area is minimal and mountain goats have not been observed on the access road area of the LSA. In the mine site area, COPCs in water and COPCs in soils resulting from fugitive dust have been identified as sources of potential chemical hazard for mountain goats.

#### Chemicals of Potential Concern in Water

Water in Brucejack Lake and the receiving environment at lower Brucejack Creek (BJ2) are predicted to exceed water quality guidelines for wildlife (Table 18.5-5; [Appendix 13-C](#)), including total metal concentrations of manganese, cadmium, and silver. Mountain goats primarily forage and drink close to escape terrain (within 500 m) to avoid predation by carnivores. A total of 1,017 ha of escape terrain were located within 500 m of Brucejack Lake and Brucejack Creek after considering the area lost to habitat loss and alteration. However, this area largely occurs within the area considered disturbed due to noise, thus would likely be avoided by goats. After totalling the high quality escape terrain lost due to habitat loss (Section 18.6.2.2) and sensory disturbance (Section 18.6.2.3), a total of 304 ha of high quality habitat (escape terrain) remains within 500 m of Brucejack Lake and Brucejack Creek. This area represents 12% of the available escape terrain in the mine site area (2,421 ha total).

Goats primarily obtain their water requirements from eating forage and snow (Ellis et al. 2007), and have occasionally been observed drinking from small streams during the summer (Foster and Rahe 1985). Therefore, it is not likely that mountain goats would use larger reservoirs such as Brucejack Lake for drinking. While it is possible that they may use Brucejack Creek for drinking in the summer, water intake from the creek would likely be minimal as the majority of their water intake comes from vegetation and snow that they consume. In addition, COPCs such as manganese and silver are not highly toxic to mammals and typically aquatic organisms are more sensitive to these COPCs (National Research Council 2005). While cadmium can be toxic to mammals, large chronic dietary concentrations of cadmium (e.g., 3 - 25 mg/kg daily for > 8 years) are required through diet and water to result in toxic effects such as nephrotoxicity, and histopathological changes in liver and kidney (National Research Council 2005). It is therefore unlikely that uptake of COPCs from waters from Brucejack Lake or Brucejack Creek would result in health effects in mountain goats. Thus, the uptake of COPCs from water is not considered further in the assessment for mountain goat.

#### Residual Effects for Mountain Goats due to Chemical Hazard

After mitigation, no residual effects were predicted for mountain goats due to chemical hazards.

### 18.6.3 Potential Residual Effects on Grizzly Bears

#### 18.6.3.1 Identifying Key Effects

Grizzly bears were assessed for potential Project related effects. Habitat loss and alteration, sensory disturbance, disruption of movement, direct mortality, indirect mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on grizzly bears. There were no effects scoped out for grizzly bears. The potential residual effects considered in the assessment for grizzly bears are summarized in Table 18.6-5, and described in the following sections, from Section 18.6.3.2 to 18.6.3.8.

**Table 18.6-5. Ranking Potential Effects on Grizzly Bears**

Project Components/ Physical Activities	Potential Effects on Grizzly Bear						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	●	●	●	●	●
Access Road	●	●	●	●	●	●	●
Transmission Line	●	●	●	●	●	●	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	●	●	●	●	●
Access Road	●	●	●	●	●	●	●
Transmission Line	●	●	●	●	●	●	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	●	●	●	●	●	●
Access Road	○	○	●	●	●	●	●
Transmission Line	○	○	●	○	●	○	○

**Notes:**

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

#### 18.6.3.2 Habitat Loss and Alteration

This assessment evaluates the effects of habitat loss and alteration on grizzly bears. Habitat loss will occur in areas where Project infrastructure overlaps high-quality grizzly bear habitat. Project infrastructure and facilities that overlap high-quality grizzly bear habitat includes the Brucejack Mine Site, Browser Aerodrome, Knipple Transfer Area, Tide Staging Area, and Brucejack Transmission Line. To evaluate the potential effects of the proposed Project on grizzly bear habitat, the RSA was mapped

using habitat suitability models for spring, summer, fall, and winter denning periods. Spring, summer, and fall habitats (using a five-class habitat model) ranked as High (habitat suitability ranking [HSR] 1) or Moderately High (HSR 2) were considered the most suitable habitat and are referred to as high-quality habitat hereafter (Figure 18.3-5; Section 18.3.4.2). Winter denning habitat (using a four-class habitat model) ranked as High (HSR 1) was considered the most suitable habitat and is referred to as high-quality habitat hereafter.

High-quality protein habitat was included as a secondary layer on habitat loss and altered maps to illustrate additional important grizzly bear habitat areas that could be impacted by the Project. Grizzly bear high-quality protein habitat consists of the following three types of available protein sources:

- high-quality moose late winter habitat because it can provide sources of carrion and winter-weakened moose for bears in the spring;
- high-quality hoary marmot habitat because they are a reliable protein source available to bears during the summer and early fall; and
- salmon spawning reaches on watercourses because of the valuable and readily available source of protein they provide to bears in the late summer and fall.

Loss and alteration of proposed provincial grizzly bear WHAs in the RSA was also assessed.

#### Grizzly Bear Habitat Requirements and Availability

The assessment of habitat loss and alteration for grizzly bear was conducted for all seasons and associated habitat requirements throughout the year (excluding 341 ha of previously disturbed habitat along the access road within the LSA). The habitat ratings use a combination of the availability of high-quality seasonal vegetation forage, and characteristics required for appropriate thermal and security cover based on a RISC-standard approach (RIC 1999a). Identification of important protein sources supplemented this assessment with the contribution of important overlapping and additional habitat areas that may be affected by the Project-related habitat loss or alteration. Spring, summer, and fall are largely defined by the availability of food sources, whereas the winter denning habitat is restricted to smaller habitat areas that can provide suitable substrate and thermal properties ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

Grizzly bears move seasonally over large home ranges during the growing seasons. Grizzly bears detected at multiple locations during baseline studies found the mean home range of female grizzly to be 1,280 ha and of male grizzly to be 6,920 ha between the summer of 2008 and the fall of 2012 ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). These home range estimates are very conservative and based on straight lines unlikely to have been actually travelled by the bears between detection locations; however, suitable habitat areas with the RSA are confined to strict regions between the highly glaciated landscape. Home ranges for coastal grizzly bears have been estimated as 5,200 ha for females and 13,700 ha for males (Khutzeymateen: MacHutchon, Himmer, and Bryden 1993), while interior grizzly bears have been estimated at 10,300 ha for females and 18,700 ha for males (Simpson, Terry, and Hamilton 1997; Ciarniello 2006).

Concentrations of bear detections occurred within the RSA along riparian areas such as the Unuk River, Treaty Creek, the Bell-Irving River and the Bowser River ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). Bears were also detected in alpine and subalpine habitat throughout the RSA during the summer months ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

**Spring:** Within the RSA, 55,391 ha of high-quality spring habitat was identified, 4,223 ha of which is within the LSA. High-quality habitat was primarily identified in low elevation riparian habitat such as around Bowser Lake and the Bowser River, Treaty Creek, Scott Creek and additional smaller watercourses south of the Bowser River in the southeast portion of the RSA (Section 18.3.4.2). In early spring, high-quality grizzly bear habitat is typically limited to lower elevations due to the deeper snow packs at higher elevations (with the exception of open avalanche chutes at mid- to high elevations). In addition, early spring habitat for grizzly bears along riparian habitat is enhanced by the presence of moose carrion from late winter moose mortality (Section 18.3.4.2).

**Summer:** A total of 77,261 ha of high-quality summer habitat was identified within the RSA, 4,923 ha of which is within the LSA. This habitat was identified at low to mid-elevations in the eastern portions of the RSA along riparian habitat and previously cleared areas (Section 18.3.4.2; [Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report). High-quality summer habitat is typically capable of producing abundant *Vaccinium* species, devils club, or other berry-producing plants, and is generally upslope from spring habitat. In addition, high-quality hoary marmot habitat occurs adjacent to or directly above many of the high-quality grizzly bear summer habitat areas, enhancing their forage value, particularly along the Sulphurets Creek, Bowser River, and Scott Creek drainages and along the west-facing slopes of Mount Anderson (Section 18.3.4.2).

**Fall:** A total of 66,606 ha of high-quality fall habitat was identified within the RSA, 5,501 ha of which is within the LSA. For the most part, these habitats were located along salmon-bearing streams such as the Unuk River and Treaty Creek drainages, and most extensively along the Bowser River floodplain (Section 18.3.4.2). Fall habitat was rated for the ability to support important fall forage such as berry producers: high bush cranberry (*Viburnum Trilobum*), huckleberries (*Vaccinium membranaceum*), blueberries (*Vaccinium ovalifolium*), and Soopolallie (*Shepherdia Canadensis*), and those with roots and tubers such as Arctic lupine (*Lupinus arcticus*) and cow parsnip (*Heracleum lanatum*). These habitats typically have an open structural stage within mature forests just upslope of valley bottoms. Important sources of fall protein were also identified along salmon-bearing watercourses such as the Unuk, Bell-Irving, and Bowser rivers, and Treaty Creek (Section 18.3.4.2).

**Denning:** A total of 57 ha of high-quality winter denning habitat was identified in small patches at high elevation in the LSA. Denning habitat was only modelled in the LSA because soil depth required from TEM mapping was only available for the LSA. High-quality denning habitat was identified in a few pockets: along the slopes west of the Brucejack Mine Site approximately 5 km away, relatively near the Knipple Transfer Area, and west of the access road below Mount Anderson (Section 18.3.4.2). Den habitat was identified based on a combination of suitable terrain, topographic and substrate features that would support denning structures such as soils, aspect, elevation, and BEC zone ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

**Proposed Wildlife Habitat Area:** A proposed provincial grizzly bear WHA overlaps 22,091 ha of the RSA and 1,827 ha of the LSA. Proposed grizzly bear WHA areas and high quality habitat modelling was calculated predominantly for the eastern side of the RSA (Figure 18.3-5; McElhanney 2007a). They were identified around Treaty Creek and the Bell-Irving River with some areas extending into the central portions of the LSA along the Brucejack Access Road and over high-rated habitat within the Bowser River floodplain. The Bowser River floodplain was consistently identified by land-management plans, suitability models, and the province as highly suitable habitat for grizzly bears (McElhanney 2007a; Rescan 2010c).

#### Grizzly Bear Habitat Loss and Alteration

Table 18.6-6 shows the maximum amount of high-quality habitat for grizzly bear that will be affected due to the Project for spring, summer, fall, and denning periods and for the proposed provincial grizzly

bear WHA. Across the four seasons, a total of 143 ha of high-quality grizzly bear habitat will be lost due to Project development, representing 0.11% of the available grizzly bear high-quality habitat within the RSA and 1.43% within the LSA (Table 18.6-6).

**Table 18.6-6. Grizzly Bear Habitat Loss and Alteration due to the Project**

Season	Habitat Lost and Altered <sup>1</sup> (ha)	RSA		LSA	
		Total Habitat <sup>2</sup> Available (ha)	Habitat Lost/ Altered (%)	Total Habitat <sup>2</sup> Available (ha)	Habitat Lost/ Altered (%)
Spring	96.56	55,391.21	0.17	4,223.43	2.29
Summer	43.06	77,260.75	0.06	4,922.97	0.87
Fall	40.43	66,605.98	0.06	5,501.39	0.73
Winter (denning) <sup>3</sup>	0.29	-- <sup>3</sup>	-- <sup>3</sup>	56.57	0.52
Four season combined	143.13	134,876.35	0.11	10,009.76	1.43
Proposed WHA	0	22,091.35	0	1,827.12	0

<sup>1</sup> *Habitat loss and alteration is calculated as the maximum extent of the Project footprint i.e., operation.*

<sup>2</sup> *Total habitat refers to high-quality habitat in the RSA and LSA; see text for definition of high-quality habitat.*

<sup>3</sup> *The winter denning area was mapped for the LSA only, due to required soils data not collected in the RSA.*

Of the 22,091 ha of proposed provincial grizzly bear WHA that overlaps the RSA (1,827 ha within the LSA), none will be lost or altered (i.e., Project footprint and buffers) by the Project. The grizzly bear WHA overlaps the eastern portion of the RSA where new infrastructure is not being developed.

The development of the Brucejack Transmission Line will create the largest habitat loss and alteration (97 ha) of high-quality grizzly bear habitat, representing 67% of the total habitat lost for high-quality grizzly bear habitat for all seasons combined, although this accounts for less than 1% of total available habitat in the RSA and LSA. The northern portion of the Brucejack Transmission Line overlaps patches of high-quality summer grizzly bear foraging areas; however, the largest contiguous areas of grizzly bear habitat along the southern portion of the Brucejack Transmission Line will not be affected by the construction or maintenance operations of the line because no clearing is required in the alpine habitat above treeline at those locations (Figures 18.6-10 and 18.6-11).

The construction of the Knipple Transfer Area and Bowser Aerodrome, on the other hand, will be within an otherwise contiguous area of high-quality grizzly bear habitat for spring foraging and will be connected to moose winter range area along the Bowser River (Figures 18.6-10 and 18.6-11). The construction of the two sites will result in 27.8 ha of lost or altered high-quality grizzly bear spring habitat. Connectivity and access to the spring feeding opportunities are larger concerns than actual habitat loss in this area. Furthermore, valuable foraging habitat for grizzly bears within the RSA includes the salmon-bearing Unuk, South Unuk, and Bell-Irving Rivers, and Treaty Creek and these areas will not be affected by Project infrastructure.

#### Residual Effects for Grizzly Bears due to Habitat Loss and Alteration

Direct habitat loss and alteration is not predicted to result in a residual effect on grizzly bears. The overall loss and alteration of approximately 143 ha of high-quality habitat is equivalent to approximately 11% of the mean estimated home range for a single female grizzly bear and 2% of the mean estimated home range for a single male grizzly bear based on conservative movement detections estimated during baseline studies within the wildlife RSA. In a regional comparison the loss of 143 ha is equivalent to 3% of a female coastal grizzly bear home range and 1% of a female interior grizzly bear home range, 1% of a male coastal grizzly bear home range, and less than 1% of a male interior grizzly bear home range (MacHutchon, Himmer, and Bryden 1993; Ciarniello 2006). Based on the grizzly bear

individuals identified in the RSA (37 bears), 3.9 ha of high-quality habitat per bear may be altered ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report).

Habitat loss and alteration is not predicted to result in a residual effect on grizzly bear populations. A minimal amount of habitat will be lost per bear identified within the RSA, within the maximum potential home range of a single bear, and relative to the available high-quality habitat. In addition, habitat loss or alteration will not occur within the proposed provincial grizzly bear WHA as a result of the Project. Therefore, with mitigation no residual effect on grizzly bears is predicted.

### 18.6.3.3 Sensory Disturbance

#### Grizzly Bear Sensory Disturbance

Potential sources of sensory disturbance for grizzly bears associated with the Project include: 1) elevated Project noise levels; 2) increased traffic volumes; 3) aircraft noise; and 4) blasting noise. Grizzly bears frequently avoid areas with high human activity and have been found to avoid habitat within 100 to 900 m of roads (Mattson, Knight, and Blanchard 1987; McLellan and Shackleton 1988; Kasworm and Manley 1990; C. Mueller 2001). Several studies indicate that grizzly bears are responsive to regular aircraft flight paths below 300 m, altering their home range, foraging patterns, and breeding behaviour (Kucera 1974; Mccourt K. H. et al. 1974; Harding and Nagy 1980; Reynolds, Reynolds, and Follmann 1986).

Noise modelling was completed to determine the area of grizzly bear habitat that may be functionally lost or degraded due to sensory disturbance during Construction and Operation. The total area of high-quality spring, summer, fall, and denning habitat that falls outside of the area of habitat lost or altered due to the Project footprint (already considered in Section 18.6.3.2), but within the noise level contours of 45 dBA (for Project noise), 75 dBA LAE (traffic), 80 dBA LAE (aircraft noise), and 108 and 120 dB Lpeak (blasting) or greater was calculated (see Section 18.5.2.3 for descriptions of the four types of noise sources).

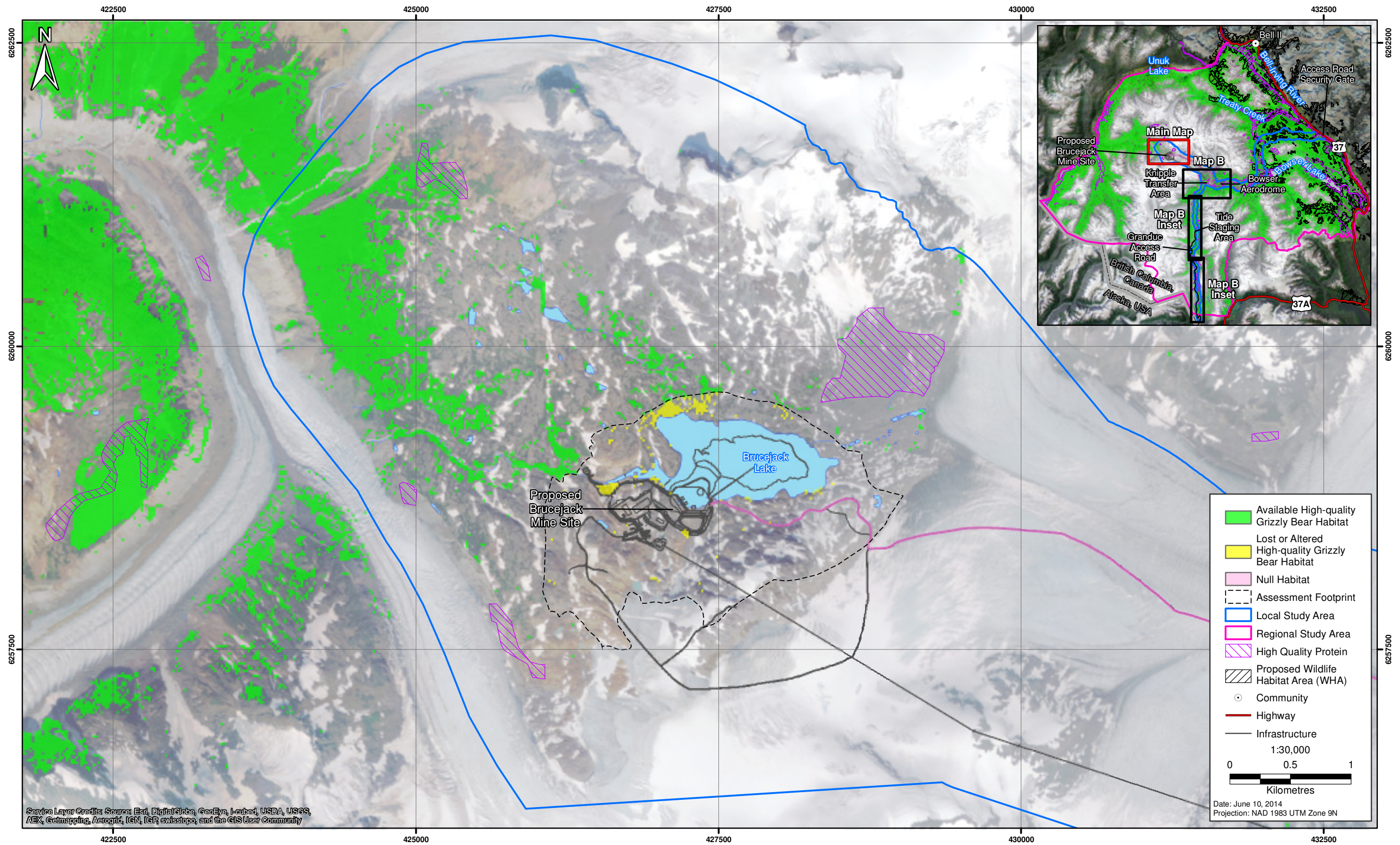
Grizzly bears do not generally respond to helicopters if flights remain 300 m above ground level (see above); therefore, helicopter noise was not included in the assessment, as helicopters will follow mitigation and management measures to remain above 300 m. Aircraft noise disturbance from fixed-wing aircraft associated with the aerodrome activities during operations is assessed in this section due to take-off and landing events below 300 m agl (McLellan and Shackleton 1989a, 1989b).

**Project Noise:** The total amount of high-quality grizzly bear habitat functionally lost due to Project noise (45 dBA Ln or greater) will be 228 ha during Construction (2.16% within the LSA and 0.16% within the RSA; Figure 18.6-12a) and 261 ha (2.47% within the LSA and 0.18% within the RSA; Figure 18.6-12b) during Operation. The majority of sensory disturbance during Construction will be along the access road from Highway 37 to the Bowser Aerodrome (124 ha; 55%). During Operation, disturbance will be associated with the Knipple Transfer Area and the Bowser Aerodrome (170.1 ha; 65%).

**Traffic Noise:** The total amount of grizzly bear high-quality habitat functionally lost or disturbed due to traffic noise during Construction and Operation (75 dBA LAE or greater), will be 2,467 ha (23% within the LSA and 2% within the RSA; Figure 18.6-12a). The majority (90%; 2,220 ha) of sensory disturbance due to traffic is along the access road from Highway 37 to the Bowser Aerodrome.

**Fixed-wing Aircraft Noise:** The total amount of grizzly bear high-quality habitat functionally lost or disturbed due to aircraft noise during Operation (80 dBA LAE or greater) will be 8,717 ha (38% within the LSA and 6% within the RSA; Figure 18.6-12c). The aircraft noise is associated with the flight path for incoming and outgoing aircraft that primarily follows the Bowser River along both the transmission line and along the access road from Bowser Lake. These flights would occur one time per day during Operation, and no flights will be conducted during Construction.

Figure 18.6-10  
Grizzly Bear High-quality Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-11  
Grizzly Bear High-quality Habitat Lost or Altered due to the Project

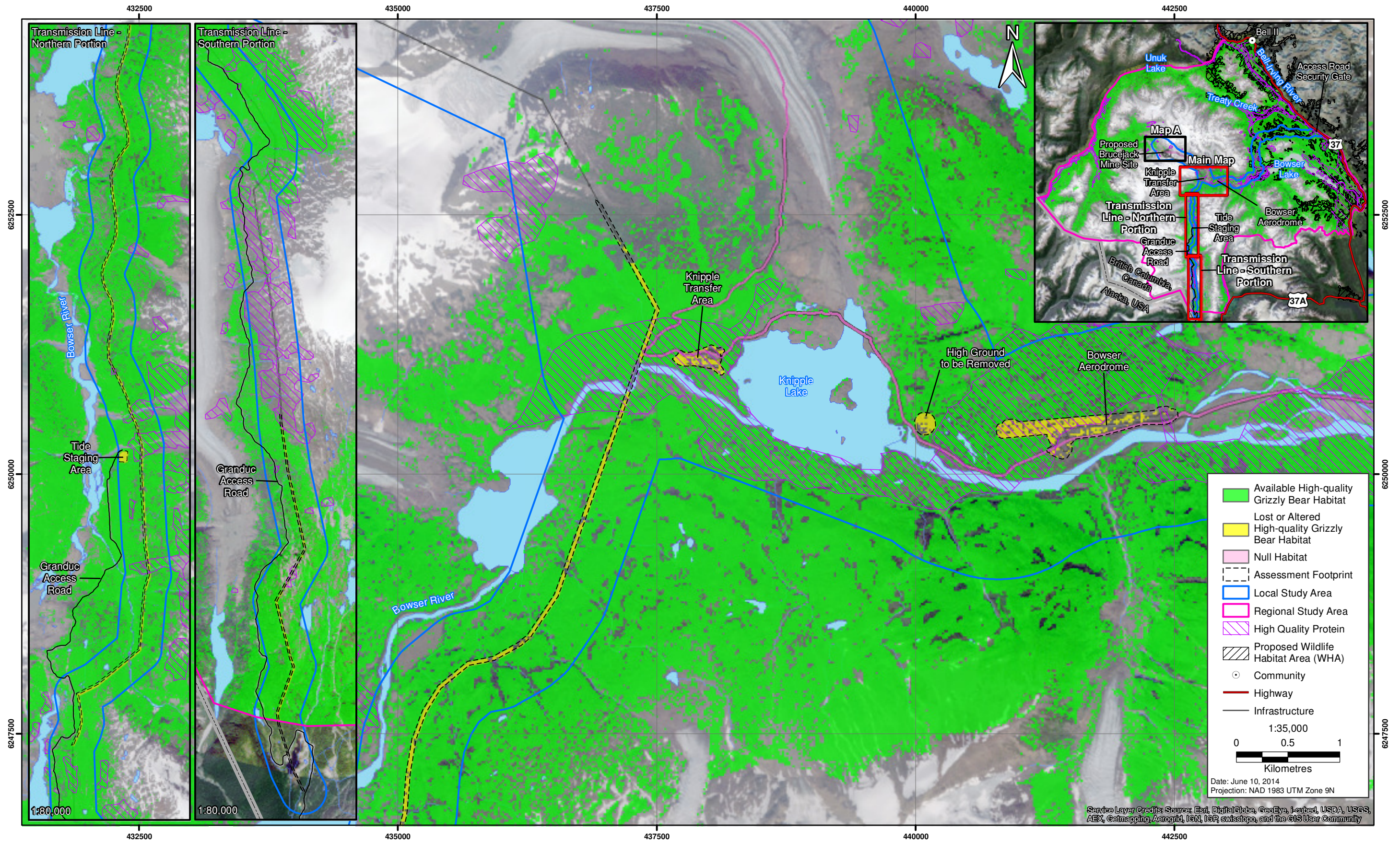


Figure 18.6-12a  
 Functional Loss of High-quality Habitat for Grizzly Bears due to Noise – Construction

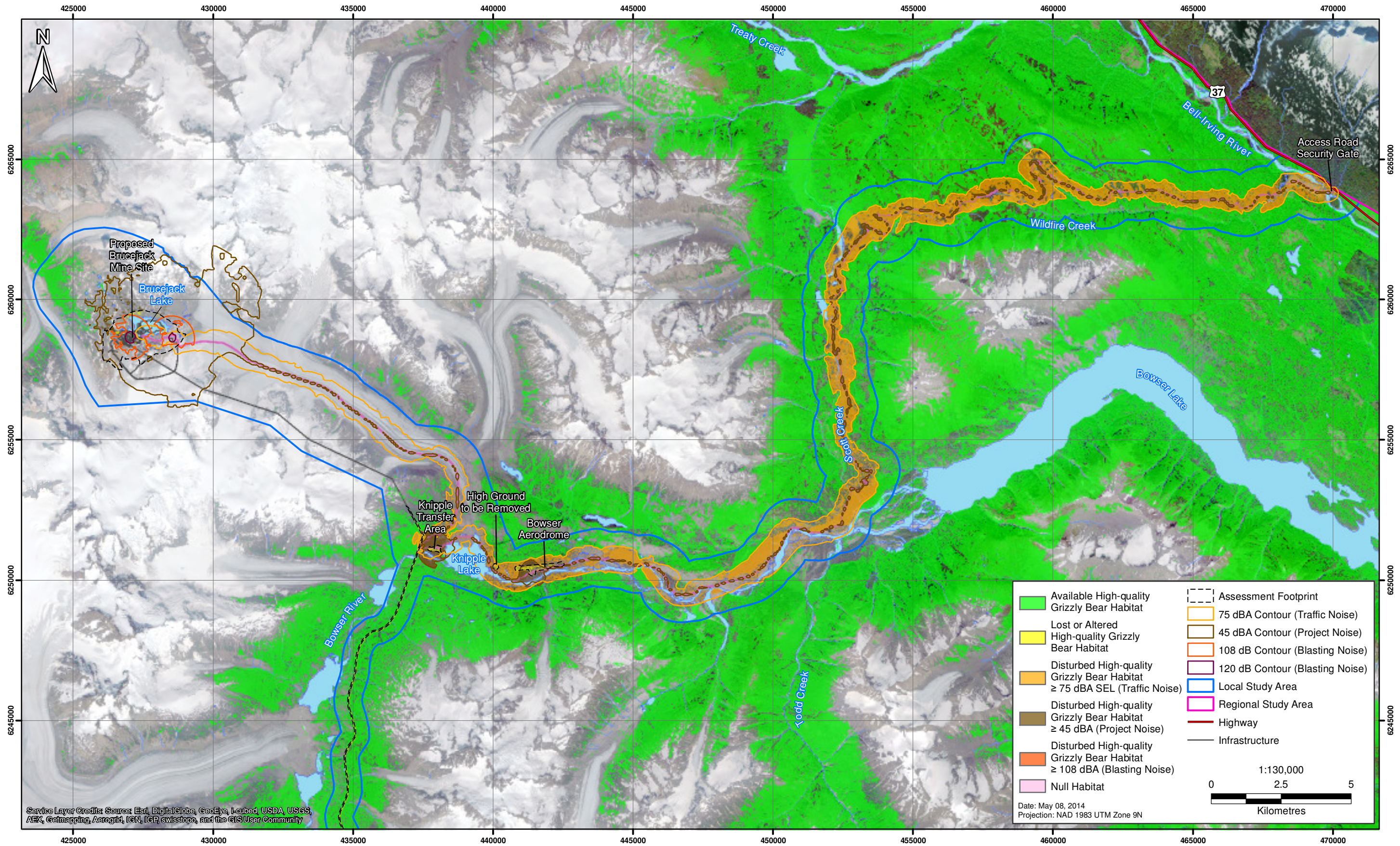


Figure 18.6-12b  
 Functional Loss of High-quality Habitat for Grizzly Bears due to Noise – Operation

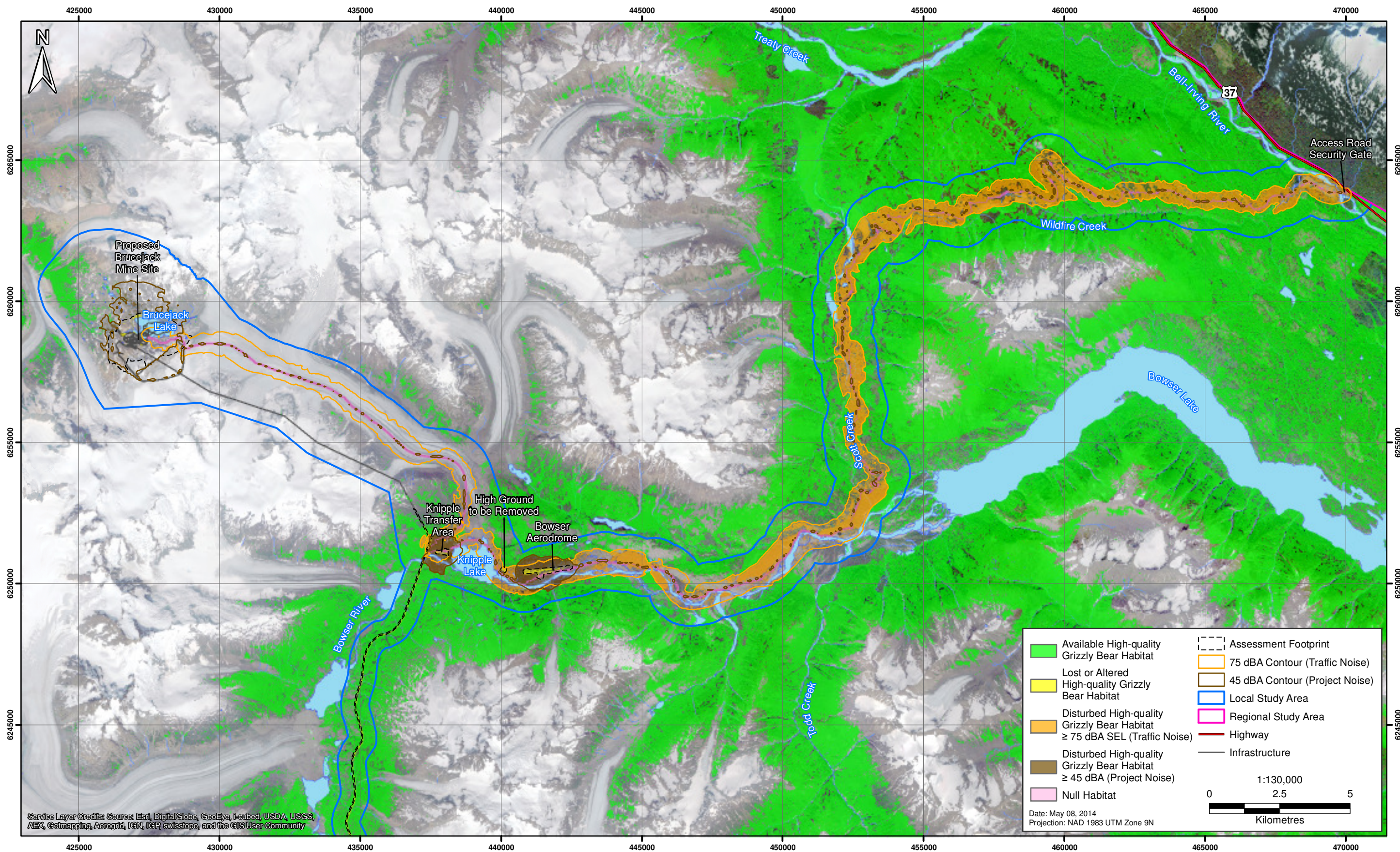
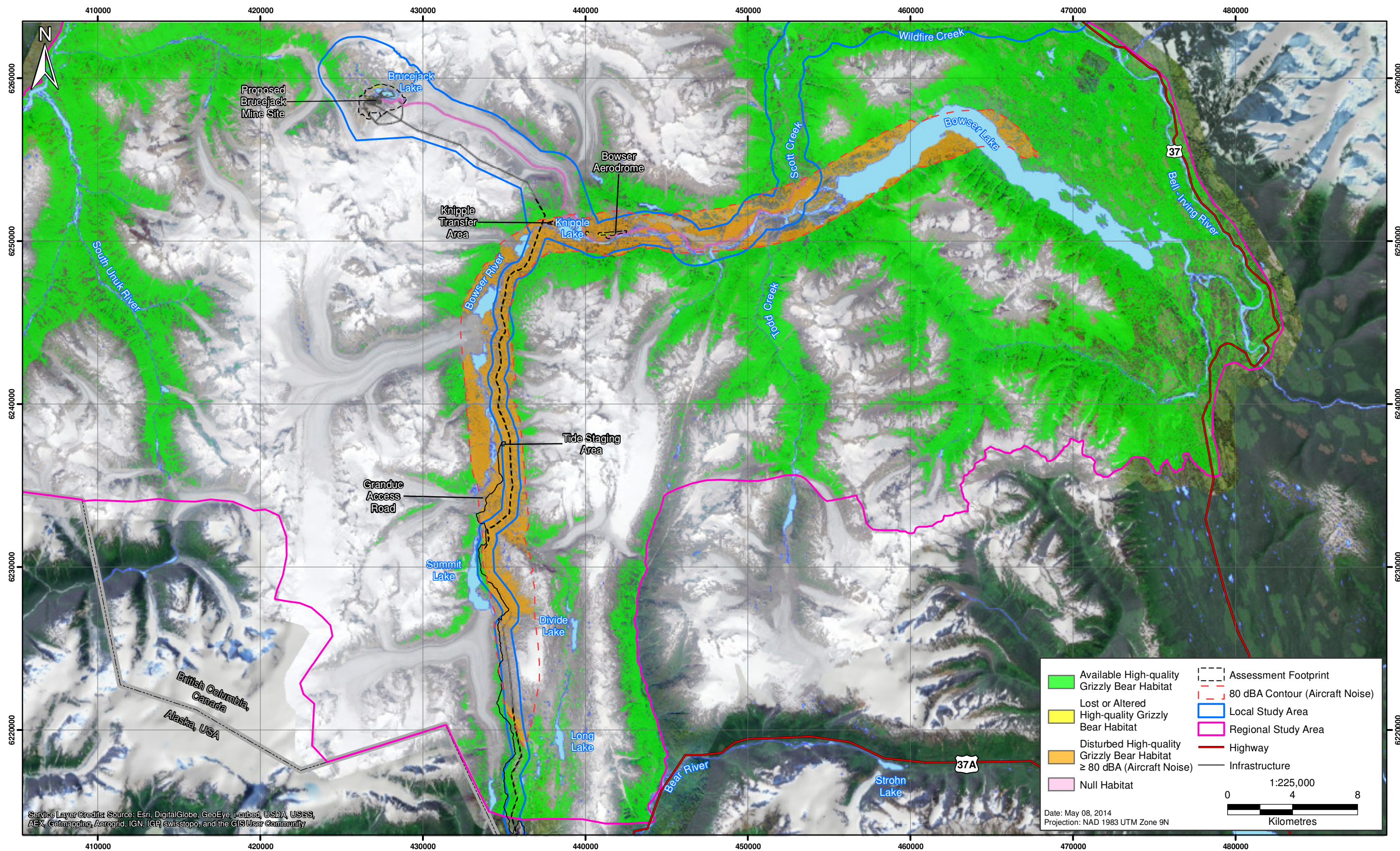


Figure 18.6-12c  
 Functional Loss of High-quality Habitat for Grizzly Bears due to Noise – Aircraft



*Blasting Noise:* Blasting noise will only affect grizzly bears during the Construction phase of the Project (Figure 18.6-12a). The total amount of high-quality grizzly bear habitat functionally lost or disturbed due to blasting noise (between 108 and 120 dBA Lpeak) will be 0.31 ha during Construction. This area of functionally lost habitat due to blasting noise will be an undetectable proportion (less than 0.001%) of high-quality habitat within the LSA.

Overall, incoming and outgoing fixed-wing aircraft will contribute the largest amount of sensory disturbance to grizzly bears. A total of 4,016 ha will be disturbed along the access road, transmission line, Knipple Transfer Area, and Bowser Aerodrome and an additional 4,701 ha will be disturbed in areas directly adjacent to the LSA along the access road and transmission line alignments. However, it is important to note that only one flight per day is planned during Operation and no flights during Construction. Therefore, although a relatively large area of high-quality habitat may be disturbed, the disturbance will be limited to once per day.

#### Residual Effects for Grizzly Bears due to Sensory Disturbance

The effect of sensory disturbance is not anticipated to have a residual effect on grizzly bears. The majority of the areas assessed with elevated noise levels that may disturb grizzly bears are along the access road as a result of traffic and aircraft and along the upper Bowser River valley near the transmission line as a result of aircraft activities during Operation. Blasting noise will not result in any measureable functional loss of habitat, and is therefore not considered further. Traffic noise will result in disturbance to 23% of available high-quality habitat in the LSA and 2% in the RSA, while aircraft noise will result in disturbance to 38% of available high-quality habitat in the LSA and 6% in the RSA.

Grizzly bear home range sizes have been estimated to range from 5,200 ha for a female coastal grizzly bear to 18,700 ha for a male interior grizzly bear (MacHutchon, Himmer, and Bryden 1993; Ciarniello 2006). Intermittent traffic noise during Construction and Operation will result in disturbance to high-quality habitat for 0.47 female coastal grizzly bear, and 0.13 male coastal grizzly bear home ranges. Aircraft noise during Operation will result in disturbance to high-quality habitat for approximately 1.6 female coastal grizzly bear home ranges and 0.47 male coastal grizzly bear home range. Therefore, of the 37 different grizzly bears that were detected within the RSA during baseline inventories, Project, traffic or aircraft noise may result in the disturbance to between 0.13 (male) and 1.6 (female) grizzly bear home ranges ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report).

Mitigation strategies will be implemented to address sensory disturbance concerns for grizzly bears. A vertical buffer flying distance will be maintained by helicopters, whenever possible, of at least 300 m above wildlife species and identified high-quality grizzly bear habitat. Noise levels will be monitored periodically at various wildlife receptor locations and mitigation strategies will be adjusted accordingly, if required (Section 29.11, Noise Management Plan). With mitigation, no residual effect of sensory disturbance on grizzly bears is anticipated.

#### *18.6.3.4 Disruption of Movement*

##### Grizzly Bear Movement Requirements

Grizzly bears maintain large individual home ranges that include separate seasonal habitats, such as wetlands in early spring and alpine areas in the late summer. Travel routes within and between habitats are variable and in most cases not easily identifiable in the landscape. The greatest potential impacts to grizzly bear movements are therefore when one seasonal habitat is isolated from another.

Research indicates that some roads may act as barriers to grizzly bear movements, effectively isolating seasonal habitats. Female grizzly bears are particularly sensitive and avoid crossing large roads (Ross

2002; Waller and Servheen 2005). When traffic volume rises above a threshold point (over 10 VPH for grizzly bears; Waller and Servheen 2005), bears may avoid a particular road, making it a barrier to movement. Grizzly bears will utilize lower traffic periods, such as at night, to cross roads (Waller and Servheen 2005). Grizzly bears have been found to avoid areas within 100 m of roads, independent of traffic volume, suggesting that even low levels of traffic can displace grizzly bears if the proper habitat characteristics are not present to facilitate crossing (McLellan and Shackleton 1988). Low-usage roads, on the other hand, can act as attractants by offering high-quality vegetation forage along their edges (Section 18.6.3.7, Attractants).

#### Grizzly Bear Disruption of Movement

The estimated maximum number of vehicles on the Brucejack Access Road per day and per hour (based on one-way trips and a 24-hour driving day), is summarized in Table 18.5-1. During Operation, the average traffic volume will be 3.58 VPH along the access road. Grizzly bears have been shown to continue to cross roads when traffic volumes are less than 10 VPH (Waller and Servheen 2005).

The Bowser River floodplain, Unuk River, Treaty Creek, Scott Pass, and slopes above Scott Creek link alpine habitat from Treaty Creek to the Knipple Glacier and may function as movement corridors for grizzly bears due to connectivity through an otherwise highly glaciated and steep landscape. Bowser River was verified as a movement pathway with multiple detections of individuals during the same summer on either side of the access road. The access road is located within this corridor; therefore, because of the high-quality habitat and large number of bears observed, bear movement may be disrupted due to traffic, despite volumes remaining below the disturbance threshold of 10 VPH.

#### Residual Effects for Grizzly Bears due to Disruption of Movement

The effect of disruption of movement is predicted to result in a residual effect on grizzly bears. Traffic contributions from the Project are not predicted to be above threshold values along the access road and the road will be reclaimed during the Closure phase of the Project (Chapter 30, Closure and Reclamation), eliminating barrier effects represented by this road alignment in the long term. However, because the road is located in high-quality grizzly bear habitat and near salmon habitat, movement to important high-quality habitat areas may be disturbed at some locations along the access road. Therefore, despite mitigation, the effect of disruption of movement is predicted to result in a residual effect on grizzly bears.

#### *18.6.3.5 Direct Mortality*

##### Grizzly Bear Direct Mortality

The potential sources of grizzly bear direct mortality in association with the Project will be vehicle collisions along the Brucejack Access Road. Destruction of problem bears as a result of safety concerns may also occur and this is assessed in Section 18.6.3.7 (Attractants) of the Application/EIS.

##### *Vehicle Collisions*

Grizzly bears may be at an elevated risk for a vehicle collision in areas that are adjacent to, provide access to, and directly overlap high-quality habitat. High-quality spring, summer, and fall habitat occurs along the access road (Appendix 18-B, 2013 Wildlife Habitat Suitability Report; McElhanney 2007a). The Treaty Creek Valley and Bowser River floodplain were identified as high-quality habitat areas because they support early seral vegetation, wetlands, and salmon spawning during the late summer and fall (Appendix 18-B, 2013 Wildlife Habitat Suitability Report). Both areas are identified within the proposed provincial grizzly bear WHA. The access road alignment directly along the Bowser River floodplain and Treaty Creek valley is connected to the access road by a potential riparian movement

corridor. Baseline studies confirmed that grizzly bears have occupied these areas, which will put them at risk of vehicle-bear collisions (Appendix 18-A, 2013 Wildlife Characterization Baseline Report). Therefore, the effect of vehicle collisions with grizzly bears, resulting in direct mortality, is assessed.

Project-related vehicles will add traffic to Brucejack Access Road, increasing the probability of vehicle-bear collisions. For data collected from 1993 to 2013, there were 34 reported vehicle accidents with bears (approximately 1.7 collisions/year) in LKI segment 3730 along Highway 37 parallel to the RSA (Sielecki 2013); however, the data do not specify whether these collisions were with grizzly bears or black bears. For the purpose of this assessment, the worst-case scenario (although unlikely) is assumed (i.e., that all events involved grizzly bears). The majority (35%), of bear collisions occurred in September (N = 12). In another census conducted between 1983 and 2012 in the Bulkley-Stikine District, the majority of strikes occurred during August and September, likely when grizzly bears are leaving alpine forage areas for lower elevation fish resources (Sielecki 2004, 2010).

It is estimated that the wildlife collision numbers recorded by the WARS system may only represent 25 to 35% of the actual number of animals killed on roads (Sielecki 2010). Therefore, if it is assumed that approximately 70% of collisions are not reported, the number of bear collisions could be 5.7 collisions per year along the highway. However, the rate of vehicle-wildlife collisions is heavily dependent on the speed of vehicles involved, with mortality rate increasing above 70 km/hour (Seiler 2005). Hence, vehicle-related mortality along the Project roads is expected to be lower per km than on Highway 37. The rate at which mortality decreases between 90 km/hour and 70 km/hour is estimated at approximately 80% (Seiler 2005), which is similar but slightly greater than the estimated under-reporting of the WARS data (approximately 70% under-reported). Therefore, traffic along the access road may result in a worst-case estimate of approximately 1.7 bear-vehicle collisions per year.

#### Residual Effects for Grizzly Bears due to Direct Mortality

The effect of direct mortality is predicted to result in a residual effect on grizzly bears from vehicle collision incidents. Potential Project-related vehicle interactions with bears will be mitigated through adherence to road and traffic signs, and cutting vegetation low along access road ROWs to ensure increased visibility of animals near the road edge. Despite implementation of mitigation measures, the possibility of grizzly bear collisions with Project vehicles may occur and a residual effect is predicted for grizzly bear direct mortality.

#### *18.6.3.6 Indirect Mortality*

##### Grizzly Bear Indirect Mortality

The potential source of indirect mortality identified for grizzly bears in association with Project development is an increase in hunting pressure and hunting incidents (e.g., defense of harvested ungulates) resulting from greater accessibility into the RSA; this potential effect is assessed in this section. Indirect mortality of bears as a result of increased hunting access is considered a greater concern than direct mortality from vehicle strikes (Ross 2002) and direct habitat change caused by the industrial activities themselves (Ciarniello 2006). Within the Central Rockies Ecosystem, for example, 90% of known human-caused grizzly bear mortalities in Alberta, and 56% in BC, occurred within 500 m of a road or 200 m of a trail (Benn, Jevons, and Herrero 2005).

The RSA overlaps three GBPU: the Upper Skeena Nass (estimated 755 grizzly bears), Edziza-Lower Stikine (estimated 398 grizzly bears), and Stewart (estimated 358 grizzly bear) GBPU (Hamilton 2012). These population units are listed as containing viable populations that are open to limited entry hunting in the spring and the fall (Hamilton, Heard, and Austin 2004; Hamilton 2012). Hunting in this area appears to be sustainable; however, improved access along the access road and transmission line

ROW could facilitate increased hunting pressure in high-quality grizzly bear habitat areas such as the Bowser River floodplain and the Todedada wetland complex areas, which were previously relatively inaccessible. In addition, grizzly bears will be attracted to the access road, especially in spring when vegetation associated with the ROW will be most attractive.

Many bears are killed each year when hunters defend a carcass during an ungulate hunt. Out of a study population of 30 grizzly bears in central-eastern BC (Parsnip River) that were radio-tracked from 1998 to 2003, 10 grizzly bears died from human-caused mortality (Ciarniello 2006), and only 33% of these mortalities were legal permitted kills. The remaining 67% were either non-permitted or killed as problem wildlife. Five of the bears were killed by hunters defending themselves, their property, or a carcass of another species. Four of the five non-permitted kills were also unreported despite compulsory inspection and reporting required by the BC MOE (2009b). Hence, the real rate of bear mortality may be three times higher than the permitted hunting kills.

Regulated hunting is focused on male grizzly bears; however, females and males are difficult to differentiate, resulting in accidental kills of females by hunters. Female grizzly bears are also killed through unregulated hunting and through poaching. Grizzly bears are particularly prized by poachers and poaching continues to be an ongoing problem for this species in BC (Blood 2002).

#### Residual Effects for Grizzly Bears due to Indirect Mortality

The effect of indirect mortality as a result of increased access via the access road and transmission line into high-quality habitat is predicted to result in a residual effect on grizzly bears. The wildlife RSA contains 37 grizzly bears, detected during DNA baseline studies. This accounts for approximately 2% of the grizzly bear population estimate within the three GBPU's overlapping the RSA (total population estimate of 1,511 individuals in the Upper Skeena Nass, Edziza-Lower Stikine, and Stewart GBPU's combined). Given that sustainable harvest can be carried out at 3% of the total population, virtually all of the bears in the RSA could be removed before a threshold was passed for these three management units combined. However, because three GBPU's overlap with the RSA, it is difficult to identify which population grizzly bears belong to and the effect is considered residual as a precautionary approach.

Areas of important habitat, including proposed grizzly bear WHAs and salmon spawning reaches, may become accessible. The Nass South SRMP (BC MFLNRO 2012) suggests a target buffer of 150 m between permanent roads and high-value grizzly bear habitat. The Brucejack Access Road will be gated and controlled, reducing the possibility of unauthorized access into the area, and will be decommissioned upon closure. Project employees and contractors will be prohibited from bringing personal firearms and weapons to work (Section 29.21, Wildlife Management and Monitoring Plan). Mitigation, however, cannot completely eliminate access and associated indirect mortality on bears, thus a potential adverse residual effect is expected from the combination of the potential increase in hunting, poaching, and incidental kills on grizzly bears.

#### *18.6.3.7 Attractants*

##### Grizzly Bear Attractants

Grizzly bears are often attracted to odours from human activity, which could result in individual bears becoming habituated "problem bears" (McLellan 1990; Blood 2001, 2002; COSEWIC 2002b). Once a bear becomes habituated to either humans or food, the probability of a negative human-bear interaction increases (Herrero 1985; Peine 2001). This section assesses the effect of attractants on grizzly bears.

Human-bear conflicts often negatively affect the survival of bears (Haroldson, Schwartz, and White 2005). Problem bears pose a risk to human safety, which often requires their relocation or destruction

(Gibeau and Herrero 1998). In many cases, bears that are attracted to human activity centres and are perceived as a threat to life or property are destroyed. Approximately 588 of the 736 reported human-caused mortalities of grizzly bears (i.e., mortalities not associated with legal hunting) across BC from 1976 to 1999 were attributable to “defence of life and property” kills (COSEWIC 2002b).

Research has shown that in areas where effective mitigation measures are implemented, grizzly bears are able to maintain a high survival rate near human developments (Ciarniello 1997; H. Davis, Wellwood, and Ciarniello 2002), and their survival rate returns to that of bears with no known history of conflict with humans (Haroldson, Schwartz, and White 2005). Section 29.17, Waste Management Plan, outlines mitigation to be implemented to reduce the attractiveness of Project infrastructure for bears and the potential consequent conflicts. This includes measures such as exclusion fencing, proper storage of attractants, and on-site employee education. The destruction of grizzly bears will be avoided unless no other recourse is possible (and will only be conducted with due authorization from the appropriate wildlife management authority).

Grizzly bears are attracted to roadside vegetation, vehicle-killed wildlife carcasses, and road-side waste discarded during Construction and Operation. Roads with lower traffic volumes are also frequently used as travel routes by bears. These issues serve to increase the risk of bear-vehicle interactions. The Wildlife Management and Monitoring Plan (Section 29.21) outlines measures to reduce wildlife-vehicle interactions, such as low speed limits, road signs in wildlife habitats, removal of carrion along Project roads, and proper disposal of food wastes. Wildlife-vehicle and human-wildlife interactions will be reported and records compiled to help identify locations with high levels of wildlife conflicts, should they occur, to minimize the risk to bears.

#### Residual Effects for Grizzly Bears due to Attractants

The effect of attractants is predicted to result in a residual effect on grizzly bears. To minimize the effects of attractants to bears, Project activities will adhere to the Waste Management Plan (Section 29.17), and the Wildlife Management and Monitoring Plan (Section 29.21). The Waste Management Plan and the Wildlife Management and Monitoring Plan outline measures to reduce grizzly bear attractants and interactions with the Project. However, despite similar mitigation measures at other remote mines in BC, bears have still been attracted to camps, kitchens, and storage areas. With mitigation, residual effects are still anticipated for bears from attractants.

#### *18.6.3.8 Chemical Hazards*

Chemical hazards to grizzly bears were considered for both the mine site area and the access road area as high-quality habitat for grizzly bears has been identified in these areas. Uptake of COPCs associated with mine construction and operation were assessed for grizzly bears as a residual effect was anticipated due to attraction (Section 18.6.3.7), which may result in attraction of grizzly bears to areas where chemicals are stored. Bioaccumulation of COPCs through the food web as a result of consumption of prey with elevated levels of COPCs was also identified as a potential uptake pathway and considered in the assessment.

#### Chemicals of Potential Concern Associated with Mine Development and Operation

Chemicals of potential concern will be used during the construction and operation of the Brucejack mine. A description of potential COPCs that may be used is summarized in Section 18.5.7.1. Camps associated with the Construction and Operation phases of the Project will be located in areas that overlap with high-quality grizzly bear habitat. Bears are expected to largely avoid these areas during these Project phases due to habitat loss and alteration (Section 18.6.3.2) and sensory disturbance (Section 18.6.3.3). However, bears are attracted to odours from human activity such as construction camps and dumps (McLellan 1990;

Blood 2002; COSEWIC 2002b). Bears have been observed to ingest anthropogenic substances that are odorous including petroleum products such as oil and grease (BC MOE 2001).

Management and mitigation measures such as proper handling and storage of chemicals (Sections 29.7 and 29.17) and spill prevention and response measures (Section 29.14) are anticipated to effectively decrease the likelihood of chemical exposure to bears. In the event that mitigation measures do not entirely prevent bears from being exposed to chemicals used in mining and camp activities, adaptive mitigation measures will be implemented.

#### Bioaccumulation of Chemicals of Potential Concern in the Food Web

Uptake of COPCs were evaluated in several representative species of grizzly bear prey including fish (bull trout, Dolly Varden and Pacific salmon), ungulates (moose and mountain goat), and small mammals (hoary marmot and American marten). No residual effects were anticipated for uptake of COPCs in these prey species relative to baseline conditions. Thus, an increase in COPCs in grizzly bears is not anticipated to result from bioaccumulation of Project-related COPCs through the grizzly bear food chain, and this COPC pathway is not considered further for grizzly bear.

#### Residual Effects for Grizzly Bears due to Chemical Hazards

After mitigation, the effects of Project-related chemical hazards on grizzly bears are not anticipated to result in a residual effect.

### **18.6.4 Potential Residual Effects on American Marten**

#### *18.6.4.1 Identifying Key Effects*

American marten were assessed for potential Project-related effects. Habitat loss and alteration, disruption of movement, direct mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on American marten populations. Sensory disturbance and indirect mortality were scoped out of this assessment because these effects are not anticipated to interact with American marten. The potential residual effects considered in the assessment for American marten are summarized in Table 18.6-7, and described in the following sections, from Section 18.6.4.2 to 18.6.1.6.

Sensory disturbance is not considered a potential effect for American marten because winter is the most sensitive time of year for marten and there are no high-quality winter habitat areas associated with Project infrastructure. High-quality winter marten habitat is adjacent to the access road, but studies have shown that the effects of off-road vehicles on American marten distribution, sex ratios, and circadian activity are not significantly different in noise-affected versus unaffected areas when affected areas had up to five-fold increases in the frequency of noise disturbances (greater than 60 dB) per hour (Zielinski, Slauson, and Bowles 2008). Therefore, sensory disturbance is not considered to affect American marten.

Indirect mortality is not considered a potential effect for American marten because although marten are a trapped species, trapping is not anticipated to increase due to the Project, as traplines are already allocated within the RSA and are not anticipated to change. Furthermore, the Project will have a no hunting policy, which will include no additional trapping by Project employees.

Table 18.6-7. Ranking Potential Effects on American Marten

Project Components/ Physical Activities	Potential Effects on American Marten						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	○	○	○	○	○	○
Access Road	●	○	●	●	○	●	●
Transmission Line	●	○	●	●	○	●	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	○	○	●	○	●	○
Access Road	●	○	●	●	○	●	●
Transmission Line	●	○	●	●	○	○	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	○	○	●	○	●	○
Access Road	○	○	●	●	○	●	●
Transmission Line	○	○	●	●	○	○	○

**Notes:**

○ = No interaction expected; no monitoring required, no further consideration warranted.

● = Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; if minor, may require monitoring; may warrant further consideration.

● = Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.

● = Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.

**18.6.4.2 Habitat Loss and Alteration**

This assessment evaluates the effects of habitat loss and alteration on American marten. Potential effects due to habitat loss will likely occur in areas where Project infrastructure overlaps high-quality American marten habitat. Project infrastructure and facilities that overlap high-quality marten habitat include the Browser Aerodrome, Knipple Transfer Area, Tide Staging Area, and Brucejack Transmission Line. To evaluate the potential effects of the proposed Project on American marten habitat, the RSA was mapped using habitat suitability models. Winter was selected for the assessment of effects because it is considered one of the most limiting times of year for marten, and is the period when they are actively trapped for fur.

Habitats ranked as High (HSR 1) were considered the most suitable habitat and are referred to as high-quality habitat hereafter (Section 18.3.4.3). Only HSR 1 was considered high-quality habitat because the habitat suitability model for American marten used a 4-class rating scheme (Appendix 18-B, 2013 Wildlife Habitat Suitability Report).

### American Marten Habitat Requirements and Availability

Marten depend on old forests that contain large trees and coarse woody debris (Strickland and Douglas 1987; Ruggiero et al. 1994; Thompson and Harested 1994). These areas are particularly important during the winter because they host relatively high numbers of voles, which marten prefer as prey (Koehler, Blakesley, and Koehler 1990), and offer cover from predators (Spencer 1987; Buskirk and Powell 1994).

Overall, 69,616 ha of high-quality winter habitat were identified within the RSA, 5,482 ha of which were in the LSA (excluding 341 ha of previously disturbed habitat along the access road within the LSA). Much of the suitable habitat is within large contiguous riparian corridors along most of the major drainages across the RSA including Treaty Creek and the Unuk, South Unuk, Bowser, and Bell-Irving rivers.

### American Marten Habitat Loss and Alteration

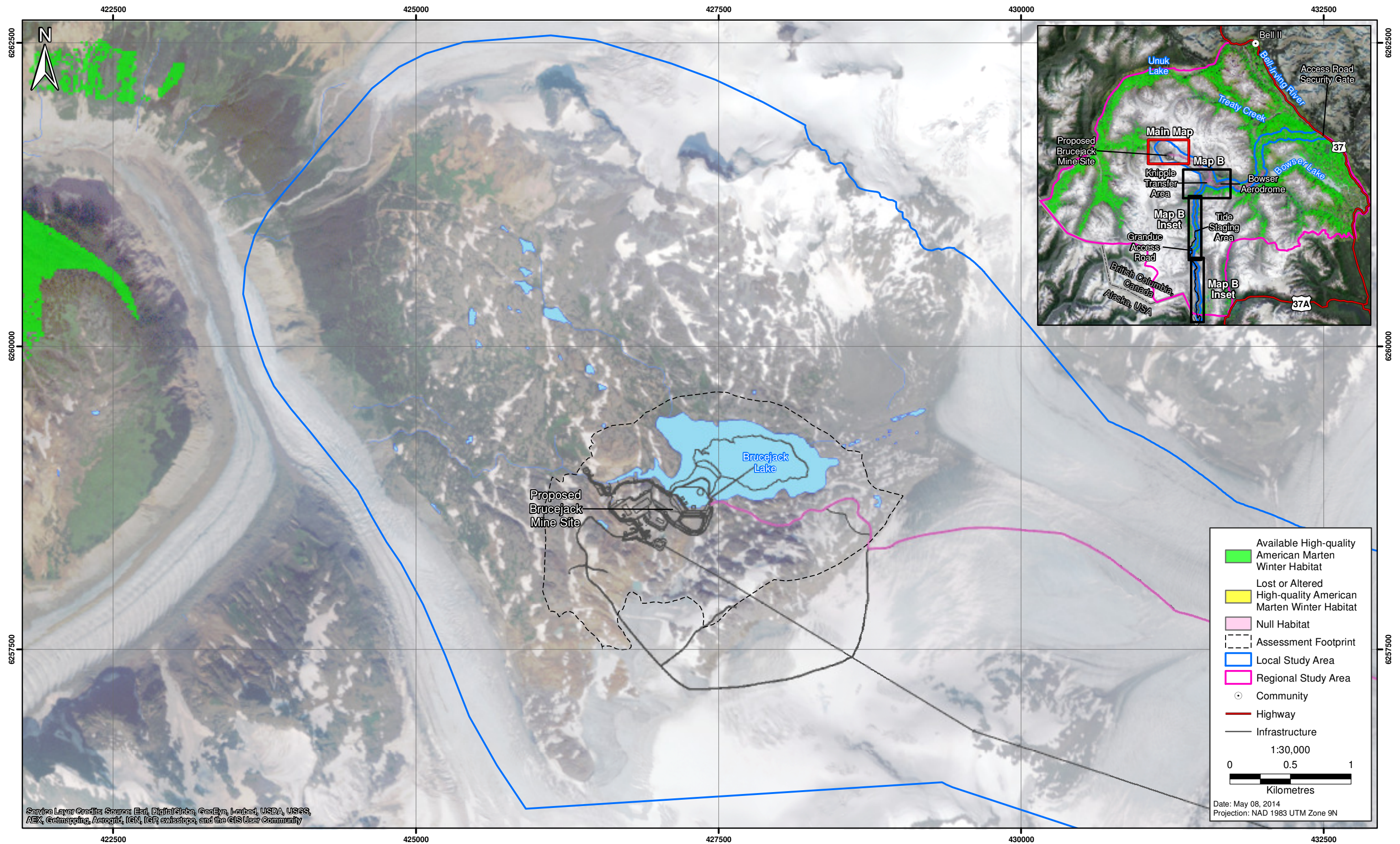
Of the 69,616 ha of high-quality American marten winter habitat identified in the RSA, 41 ha (0.06% within the RSA and 0.75% within the LSA) will be lost or altered (i.e., Project footprint and buffers) as a result of Project development (Figures 18.6-13a and 18.6-13b). The majority of high-quality American marten habitat lost (99%), will be along the Brucejack Transmission Line. The loss of habitat along the Brucejack Transmission Line will primarily occur along the northern section of the alignment where there are riparian and mature stands of forests adjacent to the Bowser River in relatively low elevation areas (Figures 18.6-13a and 18.6-13b). The southern portion of the Brucejack Transmission Line is in high-elevation habitat and cleared areas lacking forest of suitable composition and stand structure for marten winter suitability. Clearing activities at the Knipple Transfer Area, Bowser Aerodrome, and associated supporting infrastructure areas will result in less than 1 ha of lost marten high-quality habitat. There is no high-quality habitat loss or alteration at the Brucejack Mine Site because it is located at high elevation in habitat that does not support appropriate stand structure and vegetation features for marten during the winter (Figures 18.6-13a and 18.6-13b).

### Residual Effects for American Marten due to Habitat Loss and Alteration

The effect of direct habitat loss and alteration is not predicted to result in a residual effect on American marten populations due to the low amount of initial habitat loss (41 ha) and potential for reclamation and natural regeneration along the Brucejack Transmission Line, where almost all of the disturbance will occur. Reclamation at closure will be designed to restore habitat of comparable value to that lost during Project development and operation. The succession of reclaimed habitat to high-value old forest habitat will, however, take many years and will only be targeted at areas that were previously forested. Therefore, to assist in minimizing impacts to individual marten, coarse woody debris will be maintained in adjacent areas along the Brucejack Transmission Line ROW (Section 29.21, Wildlife Management and Monitoring Plan).

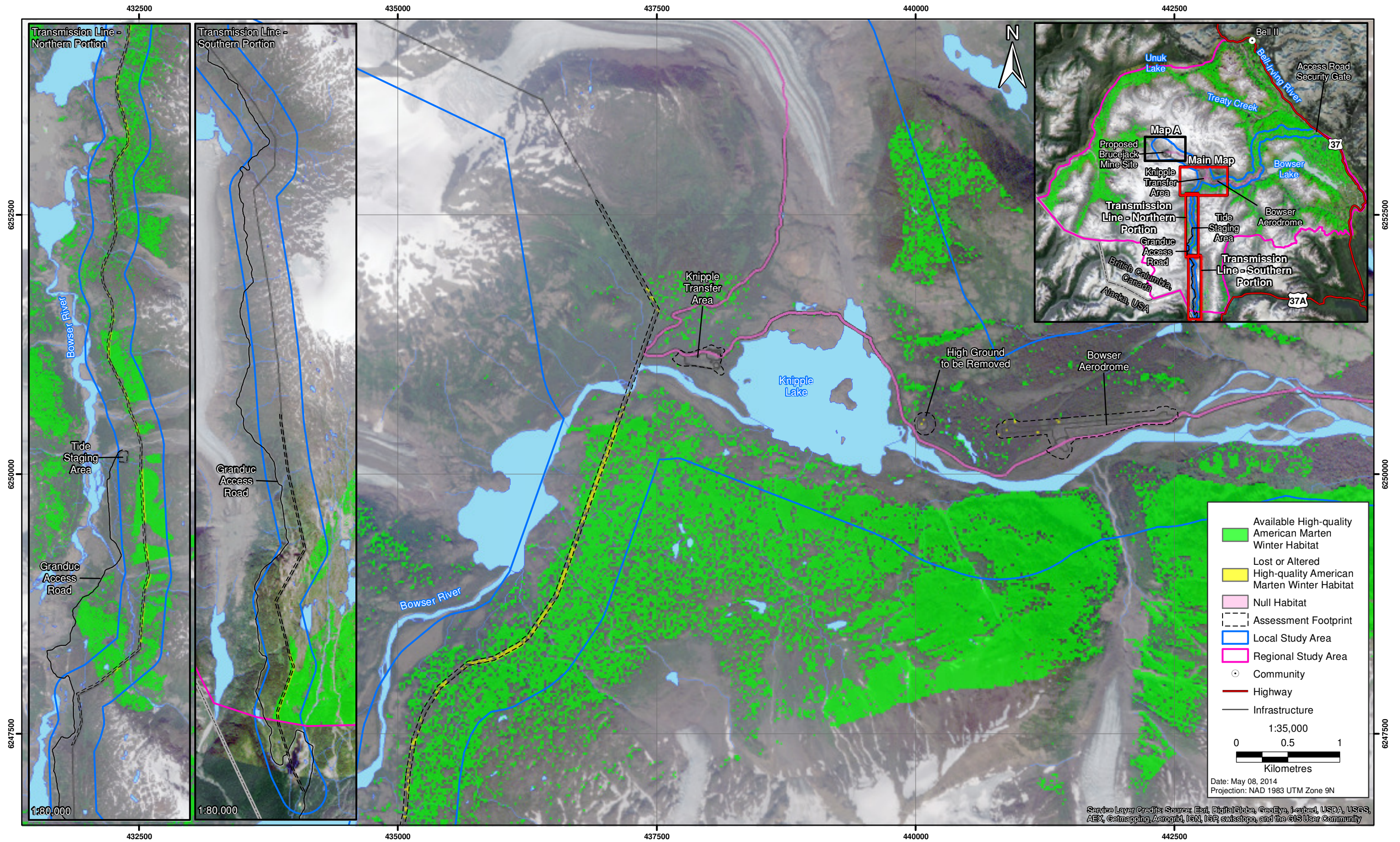
Changes to American marten home range location and size have been noted in several studies associated with forest development where greater than 25% of the habitat is modified (Leiffers and Woodward 1997; Chapin, Harrison, and Katnik 1999; Hargis, Bissonette, and Turner 1999). American marten may also abandon an area, even in the presence of increased prey abundance or low levels of fragmentation, where habitat modification exceeds 25% (Hargis and Bissonette 1997). Development of the Project will not approach this level of habitat change on a landscape scale (i.e., 0.1% of habitat in the RSA will be modified), or within the LSA (0.8%). The amount of high-quality marten habitat that will be altered (41 ha) represents 13% of the home range of a female marten and 8% of a male marten, based on average home ranges of 525 ha for males and 316 ha for females (Lofroth 1993). With mitigation no residual effect of habitat loss and alteration is predicted for American marten.

Figure 18.6-13a  
 American Marten High-quality Winter Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, IGN, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-13b  
 American Marten High-quality Winter Habitat Lost or Altered due to the Project



### 18.6.4.3 *Disruption of Movement*

#### American Marten Movement Requirements

Large tracts of treeless, early seral stage habitat can act as barriers for American marten movement (Hawley and Newby 1957; Gibilisco 1994). American marten prefer forests more than 40 years of age, avoid forest edges, and are rarely found in smaller patches of forest (Poole et al. 2004). Capture rates of marten decrease with increasing proximity to open areas (Hargis, Bissonette, and Turner 1999), and snow track movements display a clumped pattern away from roads, suggesting that they avoid roads and areas that lack overhead cover (Robitaille and Aubry 2000). American marten will not readily cross open areas wider than 100 m despite prey availability and habitat suitability between open (non-forested) patches (Bissonette and Sherburne 1993). In these fragmented landscapes, the proximity of open areas creates strips of forest edge.

#### American Marten Disruption of Movement

High-quality American marten habitat exists on both sides of the linear Project features (i.e., the access road and transmission line; Figure 18.3-7; Section 18.3.4.3). The Brucejack Transmission Line ROW and Brucejack Access Road have the potential to disrupt the movement of American marten because these features intersect high-quality marten habitat and create long linear open habitat that will be maintained throughout the life of the Project.

Fragmentation from the access road may act as a barrier between high-quality habitat areas, particularly along both sides of the road in the easterly portion of the LSA that parallels Wildfire and Scott creeks.

The Brucejack Transmission Line has relatively limited patches of high-quality marten habitat along each side of the alignment that are confined by increasing topography and alpine habitat. The literature suggests that marten will not readily cross open areas wider than 100 m (Bissonette and Sherburne 1993); the ROW will be 40-m wide, remaining below this threshold of 100 m. Therefore, the Brucejack Transmission Line is not anticipated to disrupt marten movement (Figure 18.6-13b).

Developments of the Brucejack Mine Site, Knipple Transfer Area, Bowser Aerodrome, and associated infrastructure are not anticipated to result in a disruption of movement for American marten between adjacent high-quality habitat areas. High-quality habitat was not identified around the Brucejack Mine Site and in very limited quantities at the Knipple Transfer Area and Bowser Aerodrome; therefore, it is not anticipated that marten movement will be affected in these areas (Figure 18-3.7; Section 18.3.4.3).

#### Residual Effects for American Marten due to Disruption of Movement

The effect of disruption of movement on American marten is not predicted to result in a residual effect. The Brucejack Transmission Line has been designed to be constructed with minimal clearing disturbance, ensuring that existing corridors of mature conifer forest and coarse woody debris remain available for dispersal. Operational clearing of the lines will occur but the extent of disturbance is such that a barrier is not anticipated to be created because the ROW will be approximately 40 m, which is less than the threshold of 100 m.

During the Closure phase of the Project, provisions will be made for re-establishing habitat corridors along the access road through reclamation of the access road (Chapter 30, Closure and Reclamation). The majority of the access road is also less than the 100-m threshold (30 to 80 m), and drainage culverts will assist in supporting road crossings during low flow periods. American marten are known to use drainage culverts to access habitats on either side of roads (Clevenger, Chruszcz, and Gunson

2001). After mitigation, the effect of disruption of movement is not predicted to result in a residual effect on American marten.

#### 18.6.4.4 *Direct Mortality*

##### American Marten Direct Mortality

Direct mortality of American marten could occur as a result of vehicle collisions along Project roads and vegetation clearing during Construction and Operation.

##### *Vehicle Collisions*

Marten will be susceptible to vehicle strikes during foraging periods while hunting along the ground. Marten foraging activity patterns vary seasonally. During the winter, marten predominately hunt nocturnally; during the snow-free months marten may switch to a diurnal hunting pattern (Zielinski, Spencer, and Barrett 1983; Zielinski 2000).

Marten mortality due to vehicle collisions is expected to be an infrequent event along Project roads. Marten avoid roads and areas that lack overhead cover (Poole et al. 2004). This conclusion is supported by the low reported mortality rates of marten along highways: three vehicle-marten collisions were reported in the Bulkley-Stikine District database collected between 1983 and 2007 (Sielecki 2004, 2010). Similarly, in Banff National Park, American marten made up 2% of small vertebrate road kills (Clevenger, Chruszcz, and Gunson 2003).

##### *Vegetation Clearing*

Project infrastructure vegetation clearing activities, such as felling large old growth trees and removing coarse woody debris, could cause incidental mortality of females and their offspring if these activities are scheduled during the birthing and rearing periods. Female American marten select sites in large cottonwoods and spruce trees, hollow logs, and underneath rocks for the birth of their young (Ruggiero et al. 1994). Typically, young are born in late March and then mothers typically move young to a second maternal den site (Powell, Buskirk, and Zielinski 2003). Young are able to leave the maternal den site in late spring after approximately 50 days, although they depend on parental care for several more weeks (Ruggiero et al. 1994).

##### Residual Effects for American Marten due to Direct Mortality

The effect of direct mortality is not predicted to result in a residual effect on American marten. To reduce marten mortality along Project roads, speed limits will be implemented. Incidents, if they occur, will be reported. To prevent direct mortality of American marten during site clearing activities, where possible, clearing activities will be scheduled outside of the birthing and rearing periods which occurs from March to May when marten are within denning habitat (low elevation older growth forests). If this is unfeasible, pre-clearing surveys will be conducted prior to clearing activities to identify active den sites. With mitigation, Project-related mortality is unlikely to contribute to population-level effects on marten and is not predicted to result in a residual effect.

#### 18.6.4.5 *Attractants*

##### American Marten Attractants

American marten and other furbearers may be attracted to Project features by odours, shelter, food, and prey (Ruggiero et al. 1994). Marten may be attracted to human waste and small rodent populations within camp facilities. Marten may also seek out structures for cover and denning (Hoylan, Jones, and Raphael 1998). Marten presence at camp facilities and other infrastructure typically do not present a

risk to human safety; however, they become habituated and may become injured or ingest harmful materials. Marten have been identified by the Skii km Lax Ha as special concern due to its importance as a furbearer species.

#### Residual Effects for American Marten due to Attractants

Attractants are predicted to result in a residual effect on local marten populations. To minimize the effects of attractants to American marten, Project activities will adhere to the Waste Management Plan (Section 29.17), which will include mitigation measures to store and remove all food wastes and wildlife attractants (e.g., liquid solvents, lubricants). Monitoring will be conducted with adaptive management to ensure long-term effective elimination of attractants. Marten will be prevented from accessing infrastructure with exclusion measures such as building skirting, and effectiveness of this mitigation will be monitored regularly. Wildlife awareness will also be implemented by educating employees regarding marten and waste management. Despite mitigation, it is anticipated that a residual effect may occur for American marten from Project attractants.

##### *18.6.4.6 Chemical Hazards*

The potential pathway of exposure to COPC from Project-related activities that was evaluated for American marten was the ingestion of COPC associated with mine development and operation. American marten may be exposed to COPC if they enter the Project site and are able to access and ingest these chemicals.

Chemicals of potential concern will be used during the construction and operation of the Brucejack mine. A description of potential COPCs that may be used is summarized in Section 18.5.7.1. Camps associated with the Construction and Operation phases of the Project will be located in areas that overlap with high-quality American marten habitat. American marten are expected to largely avoid these areas during these Project phases due to habitat loss and alteration (Section 18.6.4.2) and sensory disturbance (Section 18.6.4.3). However, American marten are attracted to odours from human activity such as camps (Ruggiero et al. 1994). Thus, American marten may ingest anthropogenic substances that are odorous including petroleum products such as oil and grease if they have access to these chemicals.

Management and mitigation measures such as proper handling and storage of chemicals (Sections 29.7 and 29.17) and spill prevention and response measures (Section 29.14) are anticipated to effectively decrease the likelihood of chemical exposure to American marten. In the event that mitigation measures do not entirely prevent American marten from being exposed to chemicals used in mining and camp activities, adaptive mitigation measures will be implemented.

#### Residual Effects for American Marten due to Chemical Hazards

After mitigation, the effects of Project-related chemical hazards on American marten are not anticipated to result in a residual effect.

##### **18.6.5 Potential Residual Effects on Hoary Marmots**

###### *18.6.5.1 Identifying Key Effects*

Hoary marmots were assessed for potential Project related effects. Habitat loss and alteration, direct mortality, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on hoary marmot populations. The effects of sensory disturbance, disruption of movement, indirect mortality, and attractants were scoped out of this assessment because they were determined to have no interaction with hoary marmots. The potential

residual effects considered in the assessment for hoary marmot are summarized in Table 18.6-8, and described in the following sections, from Section 18.6.5.2 to 18.6.5.4.

**Table 18.6-8. Ranking Potential Effects on Hoary Marmots**

Project Components/ Physical Activities	Potential Effects on Hoary Marmots						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	○	○	●	○	○	●
Access Road	●	○	○	●	○	○	●
Transmission Line	●	○	○	●	○	○	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	○	○	●	○	○	●
Access Road	●	○	○	●	○	○	●
Transmission Line	●	○	○	●	○	○	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	○	○	●	○	○	●
Access Road	○	○	○	●	○	○	●
Transmission Line	○	○	○	●	○	○	○

**Notes:**

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

Sensory disturbance is not considered a potential effect for hoary marmots. Marmots and small mammals in general have been shown to habituate to significant human presence, and have reproductive and survival rates comparable to marmots not exposed to human presence (Griffin 2007). In addition, potential effects due to sensory disturbance to marmots appears to lessen with repeated exposure, suggesting that marmots habituate to human disturbances relatively well (Li et al. 2011). Therefore, sensory disturbance is not considered to affect hoary marmots.

Disruption of movement is not considered a potential effect for hoary marmots because they have a relatively small home range size (13.5 ha) and so Project infrastructure is not anticipated to block or change existing movement patterns (Armitage 2000). Marmot colonies that are within the Project assessment footprint are considered under habitat loss and direct mortality (Sections 18.6.5.2 and 18.6.5.3).

Indirect mortality is not considered a potential effect for hoary marmot because although marmots have cultural value and have been a food source for some First Nations groups, they are not regularly

hunted in the region ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report); therefore, increased harvesting pressure is not anticipated as a result of the Project.

Attractants are not considered a potential effect for hoary marmot because a review of the scientific and management literature indicated no significant risks of Project-related attractants to marmots. In general, marmots prefer herbaceous forage and are unlikely to be attracted to the active mine site infrastructure or any unanticipated waste management issues.

#### *18.6.5.2 Habitat Loss and Alteration*

This assessment evaluates the effects of habitat loss and alteration on hoary marmot within the LSA. Potential effects due to habitat loss will likely occur in areas where Project infrastructure overlaps high-quality hoary marmot habitat. Project infrastructure and facilities that overlap high-quality marmot habitat includes the Brucejack Mine Site, Knipple Transfer Area, and Brucejack Transmission Line.

The hoary marmot habitat suitability model was restricted to the LSA, because soil surficial material information was available for this area and because marmots have a small home range size (Nagorsen 2005). A single habitat model was produced for this species for the growing season which is representative of a combination of habitat requirements during spring, summer, and fall ([Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report). Habitats ranked as High (HSR 1) for the models were considered the most suitable habitat for hoary marmot, and are referred to as high-quality habitat hereafter (Figure 18.3-8; Section 18.3.4.4).

#### Hoary Marmot Habitat Requirements and Availability

Hoary marmots generally live in family colonies that occupy several burrows in mountainous alpine and subalpine habitats along rocky slopes, hillsides, and alpine meadows (Nagorsen 2005). They feed on the leaves and blossoms of a variety of alpine grasses and forbs in spring and early summer; in late summer they feed on seeds (D. S. Lee and Funderburg 1982). In fall, hoary marmots enter dens where they hibernate for up to eight months of the year (Nagorsen 2005).

A total of 861 ha of high-quality habitat for hoary marmot were identified in the LSA (excluding 341 ha of previously disturbed habitat along the access road within the LSA). High-quality habitat was identified at the Brucejack Mine Site (3 ha) and along the Brucejack Transmission Line (12 ha). No to very little (less than 1 ha), high-quality marmot habitat was identified at the Bowser Aerodrome, Knipple Transfer Area, and associated infrastructure because these locations do not provide the required alpine habitat characteristics.

During baseline studies, 173 hoary marmot colonies were identified within or directly adjacent to the LSA (Section 18.3.4.4 and [Appendix 18-B](#), 2013 Wildlife Habitat Suitability Report).

#### Hoary Marmot Habitat Loss and Alteration

Of the 861 ha of high-quality habitat identified for hoary marmots in the LSA, 16 ha (2%) will be lost or altered (i.e., Project footprint and buffers) due to the Project (Figures 18.6-14a and 18.6-14b). A single marmot colony was observed in the Brucejack Mine Site assessment footprint; therefore, this colony may be altered or abandoned (Figure 18.6-14a). Twenty-three additional colonies are within the LSA portion that immediately surrounds the Brucejack Mine Site; however, the habitat associated with the colonies is not expected to be lost or altered.

Hoary marmots will re-occupy developed habitat when operations have ceased and site characteristics are restored such that they can support winter dens and suitable herbaceous forage species (MacCullum 1992; Bittman 1995).

#### Residual Effects for Hoary Marmots due to Habitat Loss and Alteration

Habitat loss and alteration is not predicted to result in a residual effect on hoary marmots within the LSA. Approximately 16 ha, representing 2% of the available high-quality marmot habitat, will be lost or altered due to development of the Project. Areas along the Brucejack Transmission Line will likely initiate natural regeneration shortly after the Construction phase because very low to no disturbance is anticipated in those areas during the Operation and Closure phases.

Based on aerial surveys conducted for baseline work, only one colony may be displaced. The colony is located within the Brucejack Mine Site assessment area, in a location that is not expected to be cleared due to infrastructure. Because of the small amount of habitat altered due to the Project, no residual effect is predicted for hoary marmots.

#### *18.6.5.3 Direct Mortality*

This assessment evaluates the effects of direct mortality on hoary marmot within the LSA. Potential direct mortality effects would occur as a result of burrow destruction during Construction phase activities or as a result of a vehicle collision along the access road.

#### Burrow Destruction during Construction Activities

Baseline surveys identified a single marmot colony within the Brucejack Mine Site assessment area, but the colony is located beyond any area designated for grubbing or physical disturbance. The number of marmots per colony is variable (2 to 30 individuals); therefore, the number of animals that may be affected within this colony is not known (Karels, Koppel, and Hik 2004). However, because the area is not anticipated to be cleared, direct mortality is not expected to occur. Pre-excavation surveys for hoary marmots will be conducted along the Brucejack Transmission Line where ground disturbance may occur in suitable habitat prior to Construction activities, as baseline surveys were not conducted along the transmission line. However, as hoary marmots inhabit alpine and subalpine areas that will include exposed rock outcrop suitable for tower base construction grubbing is not anticipated.

#### Vehicle Collisions

Vehicle collisions with hoary marmots are not anticipated. Hoary marmots occupy relatively small home ranges (approximately 13.5 ha; W. G. Holmes 1984), and foraging usually takes place within a few hundred metres of a burrow entrance (Banfield 1981). The access road does not overlap any colonies nor does it intersect high-quality hoary marmot habitat near identified colonies (Figures 18.6-14a and 18.6-14b; Section 18.3.4.). Given the small home range and relatively sedentary nature of marmots, the access road's distance from identified colonies precludes incidents of vehicle collisions along almost all sections of the road (Figure 18.3-8; Section 18.3.4.4). Colonies were observed on the slopes adjacent to Knipple Glacier in places that are within 1 km of the access road; however it is not anticipated that marmots would travel 1 km to the road, as their foraging is generally within a few hundred metres of a burrow entrance. WARS data collected from 1993 to 2013 indicate that there were two reported vehicle accidents with hoary marmots in the LKI segment 3730 along Highway 37 adjacent to the RSA, emphasizing both the typical locations of roadways relative to suitable marmot habitat and the lack of large movements by this species (Sielecki 2013).

Figure 18.6-14a  
 Hoary Marmot High-quality Habitat Lost or Altered due to the Project

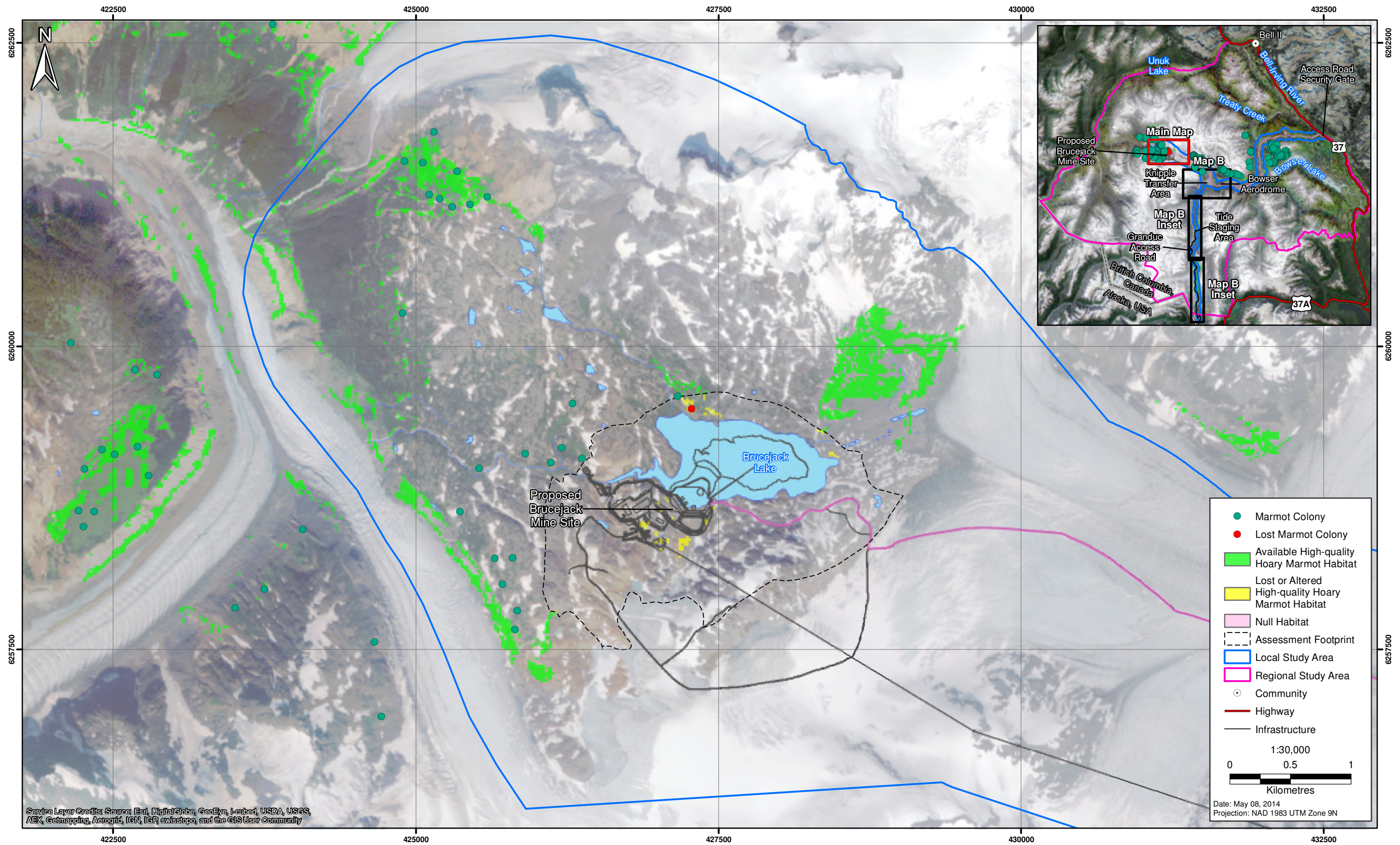
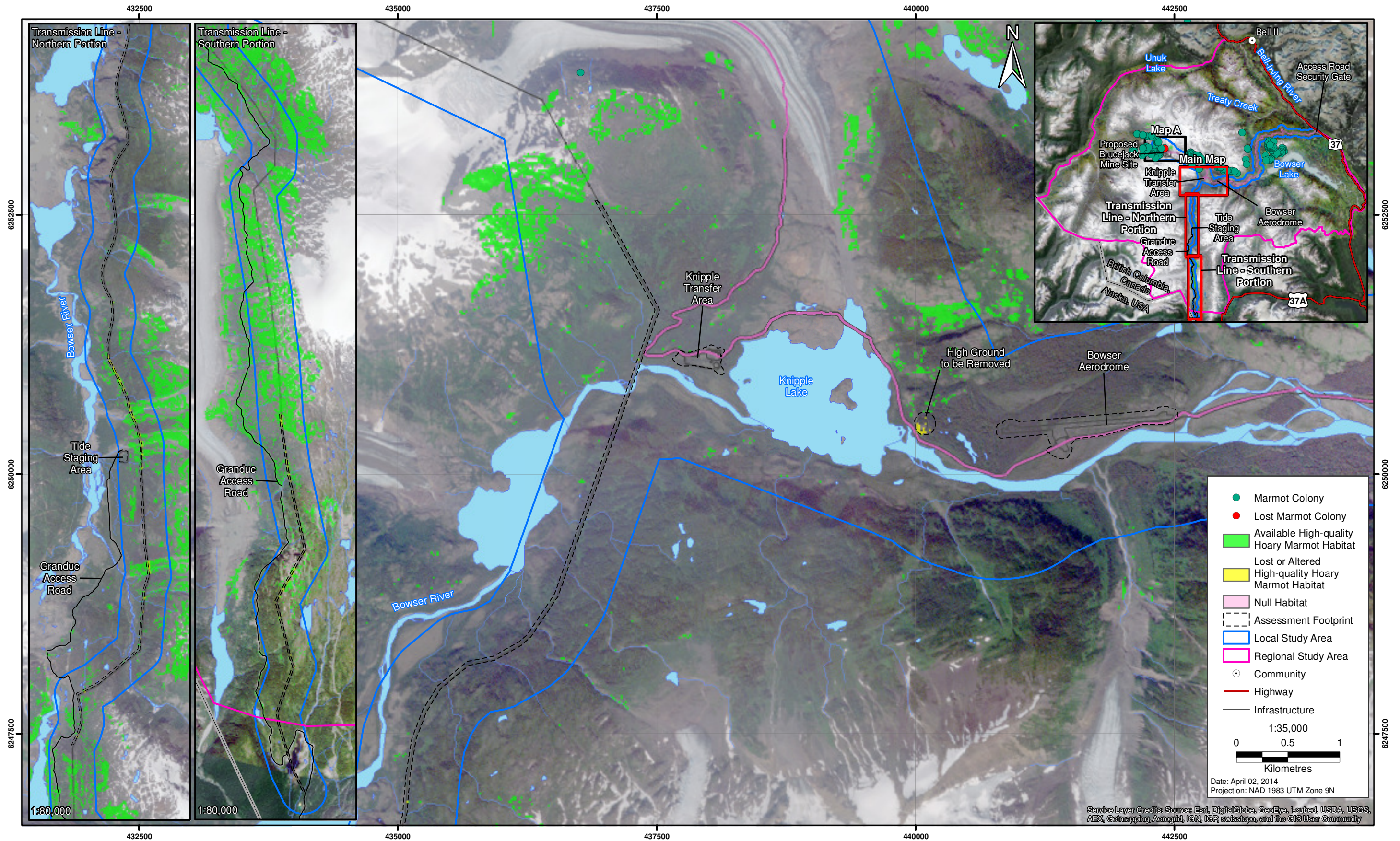


Figure 18.6-14b  
 Hoary Marmot High-quality Habitat Lost or Altered due to the Project



### Residual Effects for Hoary Marmots due to Direct Mortality

The effect of direct mortality is not predicted to result in a residual effect on hoary marmots. The minimal impacts to colonies anticipated (one colony may be impacted), combined with mitigation as described in the Transportation and Access Management Plan (Section 29.16), is expected to result in minimal to no mortality associated with burrow disturbance. Vehicle collisions with hoary marmots are not anticipated to occur. With mitigation, no residual effect of direct mortality due to clearing and traffic is predicted for hoary marmots.

#### *18.6.5.4 Chemical Hazards*

Only one potential pathway of exposure to COPC from Project-related activities was evaluated for hoary marmots: uptake of COPCs in water. Uptake of COPCs in water by hoary marmot were considered only for the mine site area as water quality is anticipated to meet guidelines in the access road area of the LSA (Chapter 13). In the mine site area, COPCs in water have been identified as sources of potential chemical hazard for hoary marmots (Section 18.5.7.1).

### Chemicals of Potential Concern in Water

Water in Brucejack Lake and the receiving environment at lower Brucejack Creek (BJ2) are predicted to exceed water quality guidelines for wildlife (Table 18.5-5; [Appendix 13-C](#)), including total metal concentrations of manganese, cadmium, and silver. High quality habitat for hoary marmot was identified adjacent to the proposed Brucejack Mine Site and a total of 29 marmot colonies were identified in the area around Brucejack Lake and the deposit (SU 2) during baseline studies.

Hoary marmots have a relatively small home range size (13.5 ha) and generally feed within 100 m of their den sites (W.G. Holmes 1984). After considering marmot colonies lost to habitat loss and direct mortality (Section 18.6.5.2 and 18.6.5.3), no additional marmot colonies were found within 100 m of Brucejack Lake. Only one additional marmot colony occurred within 100 m of Brucejack Creek that wasn't already considered lost due to habitat loss or direct mortality. In addition, it is estimated that marmots meet the majority of their water requirements through the consumption of vegetation and not drinking. It is therefore unlikely that uptake of COPCs from waters from Brucejack Lake or Brucejack Creek would result in health effects in marmot.

Thus, the uptake of COPCs from water is not considered further in the assessment for hoary marmot.

### Residual Effects for Hoary Marmots due to Chemical Hazards

No residual effects were predicted for hoary marmot due to chemical hazards.

## **18.6.6 Potential Residual Effects on Bats**

### *18.6.6.1 Identifying Key Effects*

Bats were assessed for potential Project-related effects. Habitat loss and alteration, sensory disturbance, direct mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to interact with bats and result in a residual effect on bat populations. The effects of disruption of movement and indirect mortality were scoped out of this assessment because they are effects determined to have no interaction with bats. The potential residual effects considered in the assessment for bats are summarized in Table 18.6-9, and described in the following sections, from Section 18.6.6.2 to 18.6.6.6.

Table 18.6-9. Ranking Potential Effects on Bats

Project Components/ Physical Activities	Potential Effects on Bats						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	●	○	●	○
Access Road	●	●	○	●	○	●	○
Transmission Line	●	●	○	●	○	●	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	●	○	●	○
Access Road	●	●	○	●	○	●	○
Transmission Line	●	●	○	●	○	●	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	●	○	●	○
Access Road	●	●	○	●	○	●	○
Transmission Line	●	●	○	●	○	●	○

Notes:

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

Disruption of movement is not considered a potential effect for bats because bats can avoid infrastructure by flying around obstacles. The Brucejack Transmission Line and associated cleared corridor is not anticipated to change bat movement behaviour.

Indirect mortality is not considered a potential effect for bats because the primary source of indirect mortality identified for wildlife VCs in association with Project development is increased harvesting pressure and bats are not hunted or trapped.

18.6.6.2 Habitat Loss and Alteration

This assessment evaluates the effects of habitat loss and alteration on bats, in particular maternal roosting sites which are established and important habitat features for the local bat population. Suitable maternal roosting habitat is dependent on openings in the forest and is often associated with open water and riparian habitat. Project infrastructure and facilities that overlap bat habitat includes the Brucejack Mine Site, Browser Aerodrome, Knipple Transfer Area, Tide Staging Area, and Brucejack Transmission Line.

### Bat Maternal Roosting Habitat Requirements and Availability

Bats in the RSA can roost in both caves/crevices and trees. They often select old-growth conifer forests with snags and large diameter riparian deciduous stands (Nagorsen and Brigham 1995; Ormsbee 1996; Sasse and Pekins 1996; Grindal, Morissette, and Brigham 1999; Vonhof and Wilkinson 1999). Many bat species forage for insects over open areas such as water, forest trails, or wetland meadows (Kuntz and Reichard 2012; BC CDC 2013). Maternal roosting sites are located relatively close to foraging areas (Henry et al. 2002).

Caves are an important habitat feature as hibernacula (i.e., cave where bats overwinter), since they can support large populations. Caves in this region are typically associated with karst (limestone) topography. A regional assessment of bat cave habitat determined that the Unuk River karst formation found within the RSA is not suitable for forming structures that are required to support maternal roosts. There is a lack of appropriate thermal properties and structural integrity within the material. Therefore, karst cave features were not included in the habitat suitability model and not expected to be high value hibernacula within the wildlife LSA.

The loss or alteration of mature forest within 1 km of wetlands was calculated for bat maternal roosting sites. This habitat included low elevation and moist and nutrient-rich sites, particularly those that could support large black cottonwood (*populous balsamifera ssp. Trichocarpa*) and spruce (*Picea glauca*) stands of structural stages 5 to 7, that are typically adjacent to or containing natural openings for forage opportunities (Appendix 18-B, 2013 Wildlife Habitat Suitability Report). A total of 57,135 ha of suitable bat maternal roosting forest habitat was identified within the RSA, 6,109 ha of which were in the LSA. Areas were identified within large contiguous riparian corridors along Treaty Creek and the Bowser, Bell-Irving, and Unuk rivers. Within the LSA, the majority of suitable habitat was identified along the Bowser River floodplain west of Bowser Lake.

### Bat Habitat Loss and Alteration

Of the 57,135 ha of available suitable bat maternal roosting habitat (excluding 341 ha of previously disturbed habitat along the access road within the LSA), 41.7 ha (0.07% within the RSA and 0.7% within the LSA) will be lost or altered (i.e., Project assessment footprint) as a result of Project development (Figures 18.6-15a and 18.6-15b). The majority (96%; 40.12 ha) will be lost due to the Brucejack Transmission Line, primarily along the northern portion of the alignment (Figure 18.6-15b). The majority of Project infrastructure will be located in areas with limited available mature forest capable of supporting maternal roosting sites, within 1 km of suitable wetland habitat.

### Residual Effects for Bats due to Habitat Loss and Alteration

The effect of habitat loss and alteration is not predicted to result in a residual effect on bats. Approximately 0.07% of suitable maternal bat roosting forest habitat within the RSA will be lost or altered. If clearing is scheduled from May to September within suitable habitat areas, pre-clearing surveys will focus on large-diameter trees and mitigation will be enacted around maternal bat roosting sites that are identified. The effect of habitat loss and alteration on bats is expected to be negligible; therefore, no residual effect of habitat loss and alteration on bats is predicted.

#### 18.6.6.3 Sensory Disturbance

Potential sources of sensory disturbance for bats associated with the Project include elevated noise levels and additional light sources. Bats rely on acoustics, specifically echolocation, for detecting prey while foraging; therefore, bats may be affected by noise disturbance in the Project area. Bats may also be attracted to the abundance of insect prey associated with artificial lighting, or *Myotis* species may avoid bright lights as a predator avoidance strategy (Bat Conservation Trust 2008).

## Noise

Noise disturbance was calculated for maternal roosting habitat, which represents a sensitive habitat type and includes roosting and foraging areas. Studies have indicated that bats that find prey primarily by listening to prey sounds rather than echolocation can be disturbed by noise up to 50 m from roads (Schaub, Ostwald, and Siemers 2008). Therefore, the area of noise disturbance along the access road was calculated with a 50-m buffer over suitable maternal roost habitat. Disturbance from Project noise presents a relatively constant source of disturbance. Suitable bat habitat that may be disturbed by Project noise was calculated within noise level contours of 45 dBA or higher.

**Project Noise:** The total amount of suitable maternal roosting habitat affected by elevated Project noise levels (45 dBA Ln or greater) is 120.6 ha (2% of the LSA and 0.2% of the RSA; Figure 18.6-16a) during Construction, and 90.1 ha (1.5% of the LSA and 0.2% of the RSA; Figure 18.6-16b) during Operation. The majority of Project noise during Construction and Operation will be along the access road from Highway 37 to the Bowser Aerodrome (110.1 ha; 91% and 90 ha; 72% respectively). Project noise included traffic noise as an average over a 12-hour period (Section 18.5.2.3).

**Traffic Noise:** The total amount of suitable bat maternal roosting habitat affected by elevated traffic noise levels (up to 50 m from the road), during Construction and Operation is 245.8 ha (4% of the LSA and 0.4% of the RSA).

## Light

Bats tend to evade bright lights as a predator avoidance strategy, or are attracted to lights due to the abundance of insect prey (Bat Conservation Trust 2008). The potential effect of lights on bats can be minimized by modifying light design. Using low-pressure sodium lamps, fitting lamps with ultraviolet filters, or using directional lighting can reduce the effect on bats. Limiting times when lighting is used, particularly between April and September when bats are active, can also reduce the effects on bats (Fure 2006).

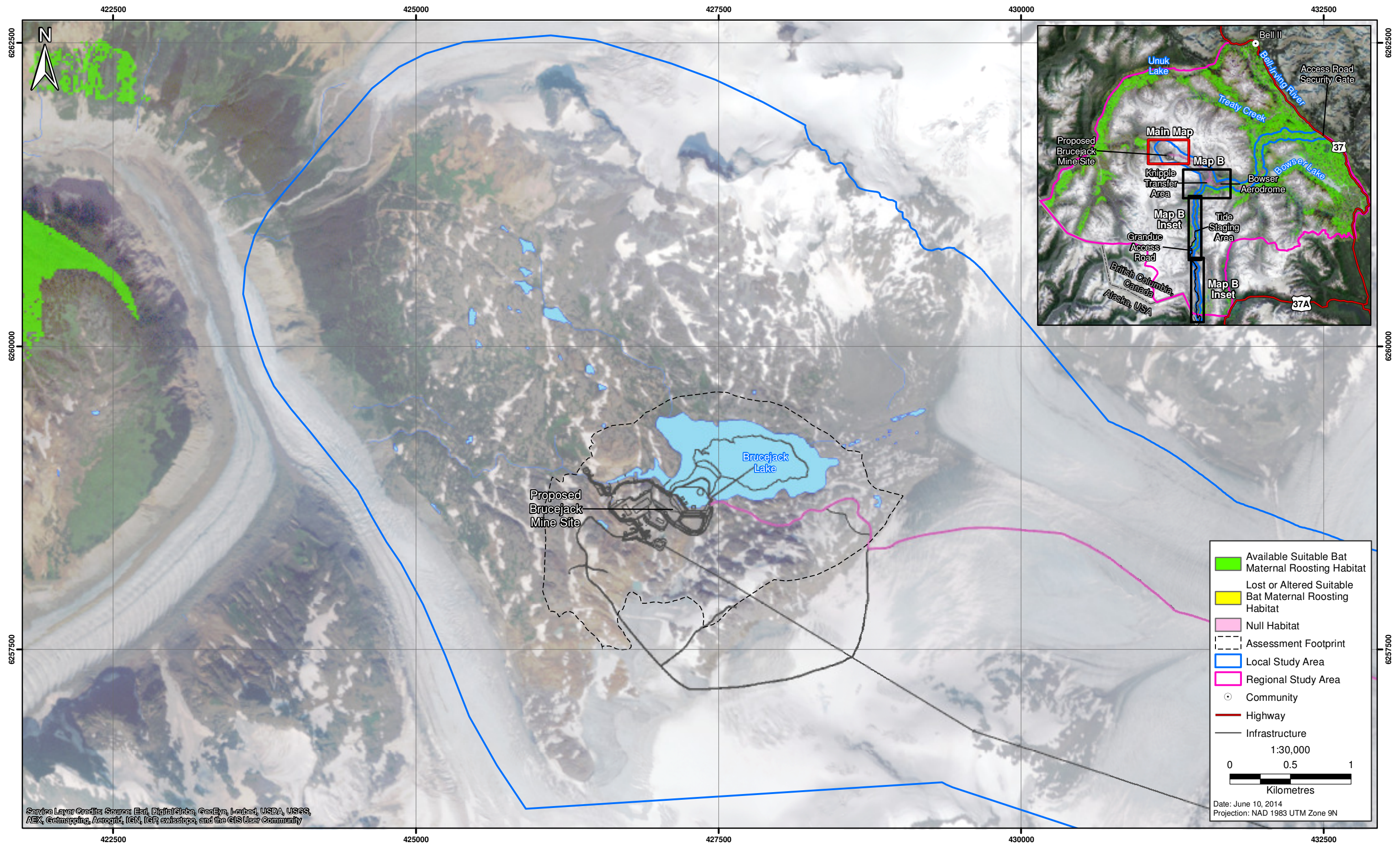
### Residual Effects for Bats due to Sensory Disturbance

The effect of sensory disturbance is not anticipated to have a residual effect on bats. The amount of suitable bat maternal roosting habitat functionally lost or disturbed due to traffic noise and Project noise during Construction and Operation will be up to 2% of the LSA and less than 1% of the RSA. Project lighting may affect bats indirectly; however, minimizing illumination and appropriate light design will reduce this effect. Following mitigation, no residual effect of sensory disturbance to bats is anticipated.

#### *18.6.6.4 Direct Mortality*

The primary source of direct mortality identified for bats is incidental destruction of cave or tree roosts during vegetation clearing and Project construction. Day roosts and maternal roosts of bats species detected within the RSA (e.g., little brown myotis and western long-eared myotis) are typically found in tree cavities and crevices, or beneath exfoliating bark in both living and standing dead trees (Nagorsen and Brigham 1995). Direct mortality for bats can occur through felling of trees that support bat roosts during clearing associated with the Project.

Figure 18.6-15a  
 Bat Maternal Roosting Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, IGN, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-15b  
 Bat Maternal Roosting Habitat Lost or Altered due to the Project

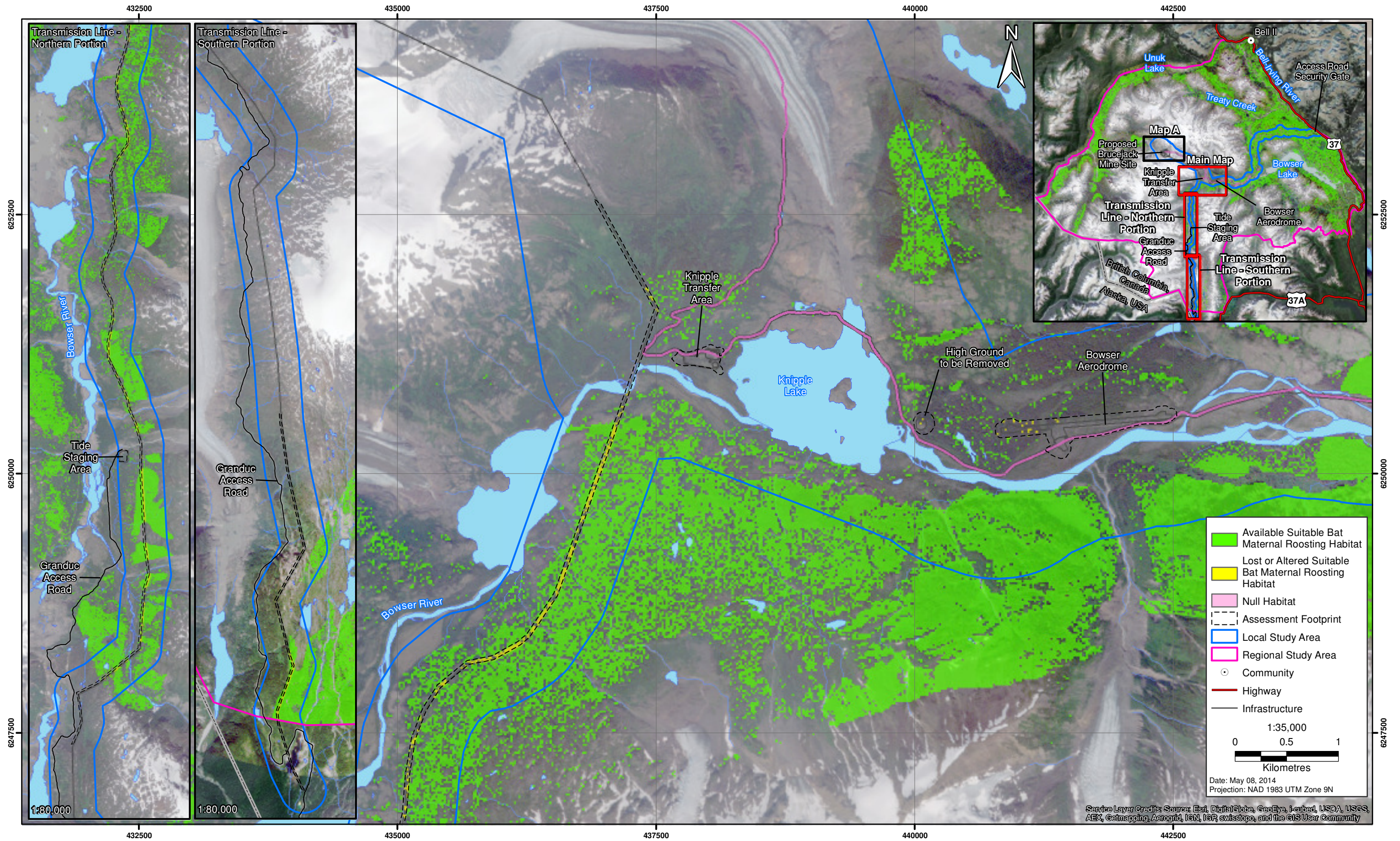


Figure 18.6-16a  
 Functional Loss of Suitable Maternal Roosting Habitat due to Noise - Construction

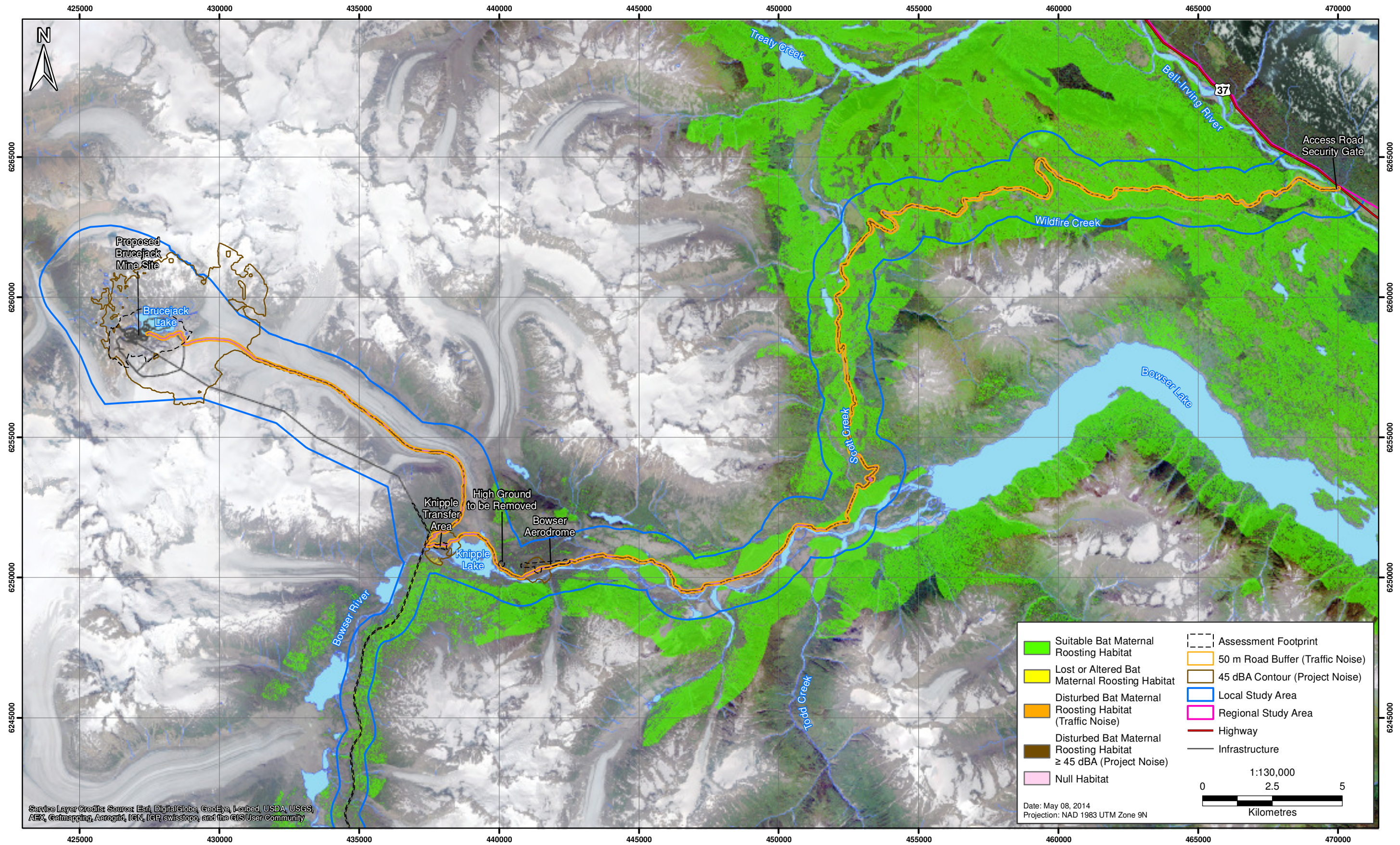
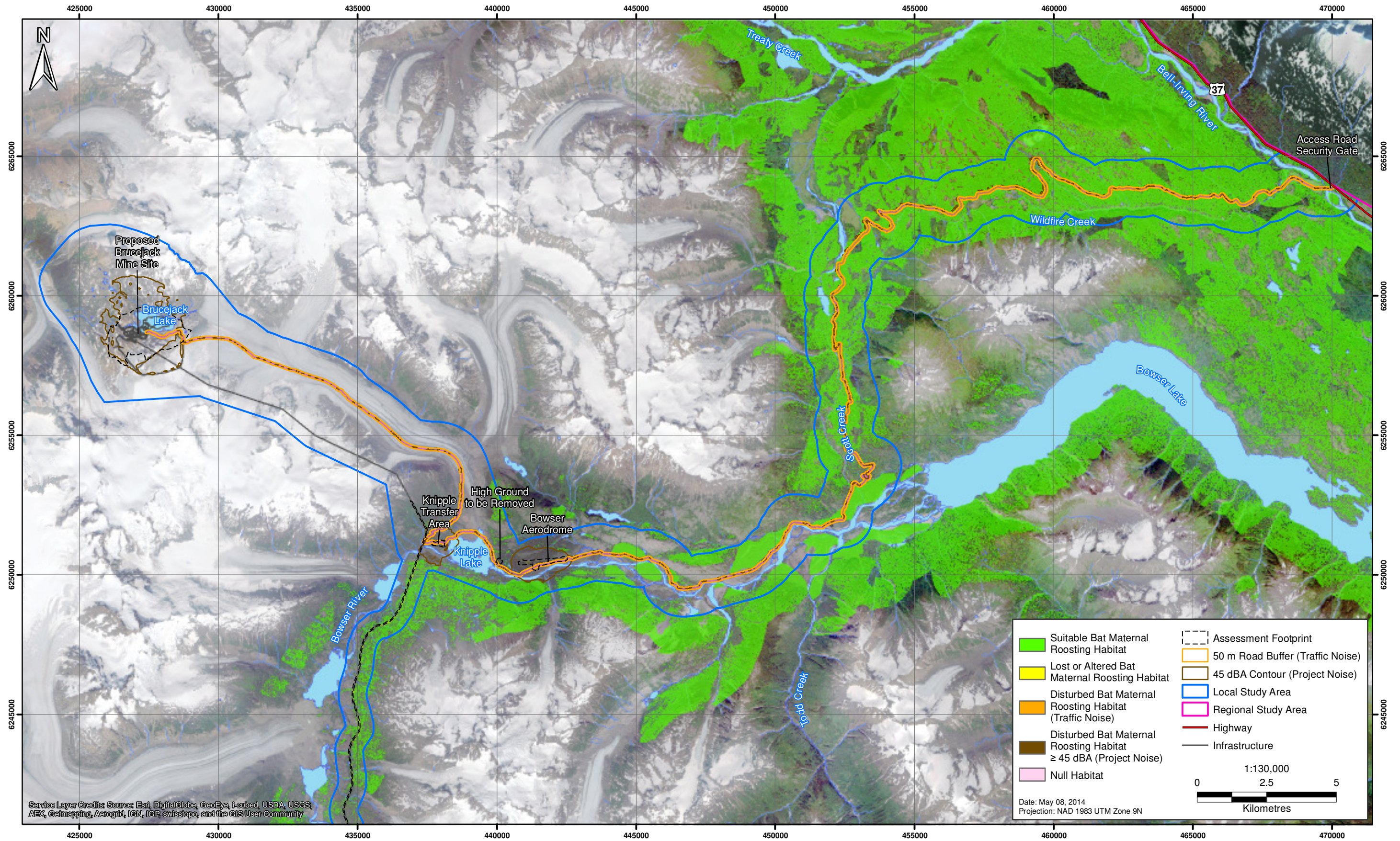


Figure 18.6-16b  
 Functional Loss of Suitable Maternal Roosting Habitat due to Noise - Operation



To minimize potential mortality from tree felling, pre-clearing surveys to identify and avoid bat roost sites will be conducted where possible within suitable habitat that could support maternal roost sites (i.e., areas of moist, mature and old-growth forests within the ICHvc or CWHwm BEC zones, including large-diameter cottonwood, fir, and spruce along riparian areas) during the maternal roosting period (May to September). If an active roost site is identified, the tree will not be felled and a suitable buffer zone will be maintained during the maternal roosting period, or BC MFLNRO (or the appropriate governing agency) will be contacted for guidance (Section 29.21, Wildlife Management and Monitoring Plan). Large roosts are unlikely to occur in the RSA due to the colder temperatures in northern BC (Kalcounis and Hecker 1995). Therefore, incidental destruction of bat roosts due to vegetation clearing would not likely affect a large number of bats.

#### Residual Effect for Bats due to Direct Mortality

The effect of direct mortality is not predicted to result in a residual effect on bats. Residual mortality effects in association with vegetation clearing are not expected for bats because high-quality habitat does not overlap areas that will be cleared and mitigation will prevent incidental destruction of roosts. With mitigation, no residual effect of direct mortality on bats is anticipated.

#### *18.6.6.5 Attractants*

Inactive underground mine facilities have been found to support bat roost sites and hibernacula (Tuttle and Taylor 1998) but there is no evidence bats used the underground opening at site during the inactive period from the late 1980's to 2011. Other man-made structures, such as buildings and crevices in the rocks produced by excavation, may also be used as roosting sites by several species of bats (Nagorsen and Brigham 1995). Bats may be attracted to these facilities and structures as roosting habitat during the Post-closure phase. Bats may be harmed if they roost in Project facilities and sites that were inactive but subsequently become re-activated.

#### Residual Effects for Bats due to Attractants

The effect of attractants is not predicted to result in a residual effect on bats. Features at the Brucejack Mine Site and other infrastructure areas (e.g., lighted areas and underground facilities) will be monitored for bat activities and evidence of roosting during Operation to identify areas that may require potential mitigation or protection measures. During Post-closure, monitoring protocol will include presence/absence assessment of mine infrastructure such as the portal and ventilation shafts to ensure they are not being used by bats before being decommissioned (Chapter 30; Closure and Reclamation Plan). Identified active bat roosts or hibernacula will be adaptively managed to discourage use and prevent future roosting (Section 29.21, Wildlife Management and Monitoring Plan). After monitoring and mitigation, no residual effects of attractants on bats are expected.

### **18.6.7 Potential Residual Effects on Raptors**

#### *18.6.7.1 Identifying Key Effects*

Raptors were assessed for potential Project related effects. Habitat loss and alteration, sensory disturbance, direct mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on raptor populations. The effects of disruption of movement and indirect mortality were scoped out of this assessment because they were determined to have no interaction with raptors. The potential residual effects considered in the assessment for raptors are summarized in Table 18.6-10, and described in the following sections, from Section 18.6.7.2 to 18.6.7.6.

**Table 18.6-10. Ranking Potential Effects on Raptors**

Project Components/ Physical Activities	Potential Effects on Raptors						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	●	○	●	○
Access Road	○	○	○	●	○	●	○
Transmission Line	●	●	○	●	○	●	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	●	○	●	○
Access Road	●	○	○	●	○	●	○
Transmission Line	●	○	○	●	○	●	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	○	○	●	○	●	○
Access Road	○	○	○	●	○	●	○
Transmission Line	○	○	○	●	○	●	○

**Notes:**

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

Disruption of movement is not considered a potential effect for raptors as these species can avoid infrastructure by flying around or over obstacles. Developments can impede the movements of raptors due to mortality from collisions with tall structures such as communication towers and wind turbines (Erickson, Johnson, and Young Jr 2005); however, the Project does not have any tall structures. Transmission line infrastructure is discussed in the direct mortality section. No tall structures will be constructed for the Project and thus interactions of raptors with the Project are not expected to result in any effects on the movements of raptors.

Indirect mortality is not considered a potential effect for raptors. The primary source of indirect mortality identified for wildlife VCs in association with Project development is increased harvesting pressure, and raptors are not hunted or trapped to the extent that populations would be affected.

**18.6.7.2 Habitat Loss and Alteration**

The assessment evaluates the effects of habitat loss and alteration on raptors. Potential effects due to habitat loss will occur in areas where Project infrastructure overlaps suitable raptor nesting habitat (excluding 341 ha of previously disturbed habitat along the access road within the LSA). The Project areas are known to support at least six different species of raptors, including the northern goshawk, short-

eared owl, bald eagle, golden eagle, northern harrier, and red-tailed hawk. All raptors are afforded legal protection in BC. Raptor nests and surrounding habitat are sensitive elements, which are protected under the *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) and managed through provincial best management practices (BC MWLAP 2005). Appropriate mitigation will be applied to ensure compliance with the *Wildlife Act* (1996).

Raptors have a variety of nesting patterns. Bald eagles and golden eagles build large stick platform nests at the tops of large, old trees. Northern goshawks typically prefer to nest in large tracts of contiguous mature or old-growth forest, which are found along river and creek drainages within the RSA (BC MWLAP 2005; BC ILMB 2009). Some raptors, including northern harrier and short-eared owls, do not nest in trees, instead creating nests on the ground.

Riparian habitats and salmon spawning reaches are an important source of protein for raptors such as bald eagles. Multiple bald eagles may feed collectively in areas with a high abundance of spawning salmon during the fall. These feeding locations are typically found along rivers with large spawning salmon populations, and at locations where there are barriers to fish passage, or where fish are forced to the surface, and where large riparian trees are present for hunting raptors to perch. There were no seasonal congregations of bald eagles on salmon streams observed during baseline studies.

#### Raptor Habitat Requirements and Availability

To evaluate the potential effects of the proposed Project on raptor habitat, the BEC system was used to identify potential suitable nesting habitat for forest nesting raptors (e.g., northern goshawk). Suitable nesting habitat for raptors was defined as mature and old-growth forests from Predictive Ecosystem Mapping, including structural stages 6 and 7 in all BEC zones, and old, large deciduous trees (structural stage 5) in floodplain forests in the ICHvc and CWHwm BEC zones. A large amount of suitable forest nesting habitat was modelled within the RSA (74,569 ha) and the LSA (6,230 ha).

Ground-nesting raptors, including the short-eared owl and northern harrier, frequently choose a nesting site adjacent to wetlands where they forage for small mammals (Wiggins, Holt, and Leasure 2006; COSEWIC 2008). Breeding habitat consists of open country with short vegetation, including rangelands, grasslands, near dry marshes, bushy fields, and forest clearings (Campbell, Dawe, McTaggart-Cowan, Cooper, Kaiser, Stewart, et al. 1997). Suitable habitat for the short-eared owl was mapped to represent ground-nesting raptors. Suitable habitat included the ICHvc (Interior Cedar Hemlock very cold) BEC zone with open habitat modifiers as well as wetland habitat. Within the RSA, 48,089 ha of suitable ground-nesting habitat was modelled, and 4,134 ha in the LSA.

#### Raptor Habitat Loss and Alteration

Of the 74,569 ha of available forest nesting habitat in the RSA, 42 ha (0.06% of the RSA and 0.7% of the LSA) would be lost or altered (i.e., Project assessment footprint) due to Project development (Table 18.6-11; Figures 18.6-17a and 18.6-17b). Of the 48,089 ha of available ground-nesting habitat in the RSA, 3 ha (0.007% of the RSA and 0.08% of the LSA) will be lost or altered. Table 18.6-11 shows the maximum amount of potential nesting habitat for forest and ground-nesting raptors that will be affected due to the Project (Figures 18.6-18a and 18.6-18b).

Habitat loss and alteration of forest nesting raptor habitat will occur primarily as a result of the Brucejack Transmission Line (approximately 40 ha). All of the approximately 3 ha of habitat lost or altered for the short-eared owl will be lost due to the Brucejack Mine Site; however, it is very unlikely that short-eared owls nest in the high elevation habitat near the mine site area and there have been no observations of owls at the mine site.

**Table 18.6-11. Raptor Nesting and Short-eared Owl Breeding Habitat Loss and Alteration due to the Project**

Raptor Habitat	Habitat Lost and Altered <sup>1</sup> (ha)	LSA		RSA	
		Total Habitat Available (ha)	Habitat Lost/ Altered (%)	Total Habitat Available (ha)	Habitat Lost/ Altered (%)
Raptor Nesting	41.7	6,230	0.7	74,569	0.06
Short-eared Owl Breeding	3.3	4,134	0.08	48,089	0.007

<sup>1</sup> Maximum loss and alteration of habitat is given whether it occurs during the Construction or Operation phases; see text for definition of habitat loss.

Residual Effects for Raptors due to Habitat Loss and Alteration

After mitigation, habitat loss and alteration is not predicted to result in a residual effect on forest-nesting raptors or ground-nesting raptors (including the short-eared owl). The 41.7 ha of raptor nesting habitat in forests that will be affected is 0.06% of the total amount of nesting habitat available in the RSA and 0.7% of the total amount of nesting habitat available in the LSA. The amount of short-eared owl breeding habitat that will be affected is 3.3 ha or 0.007% of the total amount of nesting habitat available in the RSA, and 0.08% of the total amount of nesting habitat available in the LSA.

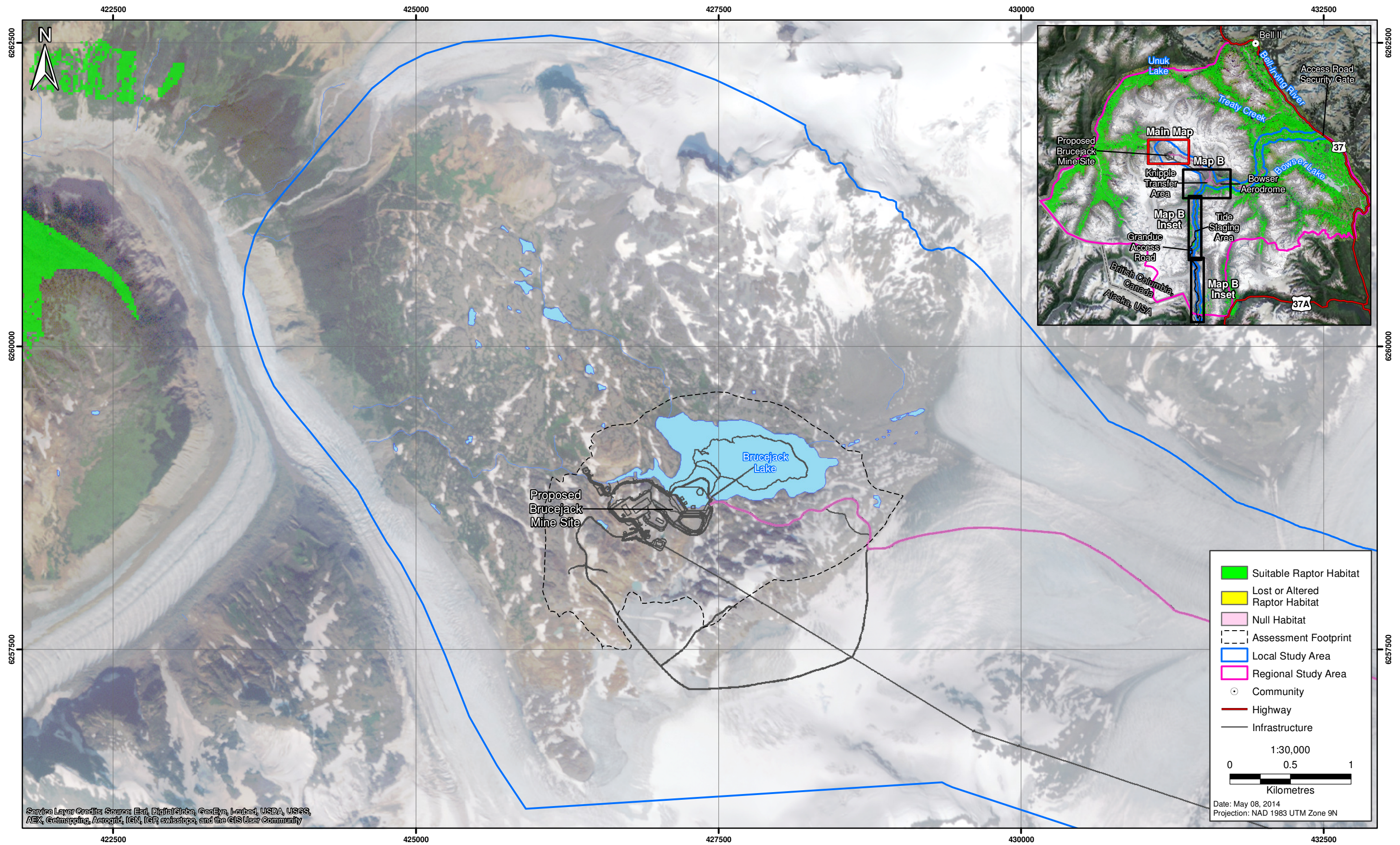
Mitigation for nests will include: (1) pre-clearing surveys to identify active and non-active raptor nests in trees as well as cavities; (2) clearing trees outside of the raptor breeding period where active nests are present; (3) establishing and adhering to buffer zones around active raptor nests during raptor sensitive periods (typically March to August); and (4) pre-construction ground clearing will be conducted outside of sensitive nesting periods for short-eared owls. If construction cannot be scheduled outside of sensitive nesting periods, a qualified on-site monitor will conduct pre-clearing surveys for nesting raptor species. If an active nest cannot be avoided or work must be undertaken within buffer areas, the BC MFLNRO would be consulted and a nest monitoring program initiated where necessary. Inactive raptor nests or nests found outside of the breeding season would be maintained or relocated, where practical, in consultation with the BC MFLNRO (Section 29.21, Wildlife Management and Monitoring Plan). At Closure, no reclamation will be conducted specifically for raptor habitat. With mitigation measures, no residual effect due to habitat loss and alteration on raptors and short-eared owls is predicted.

**18.6.7.3 Sensory Disturbance**

Potential sources of sensory disturbance for raptors associated with the Project include elevated Project noise levels and human presence. Elevated noise is a concern for raptor species that use sound for prey location such as owls.

Studies have reported that raptors are affected by disturbances as varied as pedestrian foot traffic to military training procedures (D. E. Andersen, Rongstad, and Mytton 1990; Richardson and Miller 1997; Schueck, Marzluff, and Steenhoff 2001). Behavioural responses can be as straight forward as nest abandonment or decreased egg incubation leading to mortality of embryos or nestlings, to more subtle effects such as home range shifts and decreased energy intakes due to changes to foraging behaviour (White and Thurow 1985; D. E. Andersen, Rongstad, and Mytton 1990; Richardson and Miller 1997). Spatial and temporal buffer distances have been recommended surrounding nest sites in order to minimize disturbance effects (Richardson and Miller 1997; SKCDC 2003; BC MWLAP 2004b).

Figure 18.6-17a  
Raptor Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, IGN, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-17b  
 Raptor Habitat Lost or Altered due to the Project

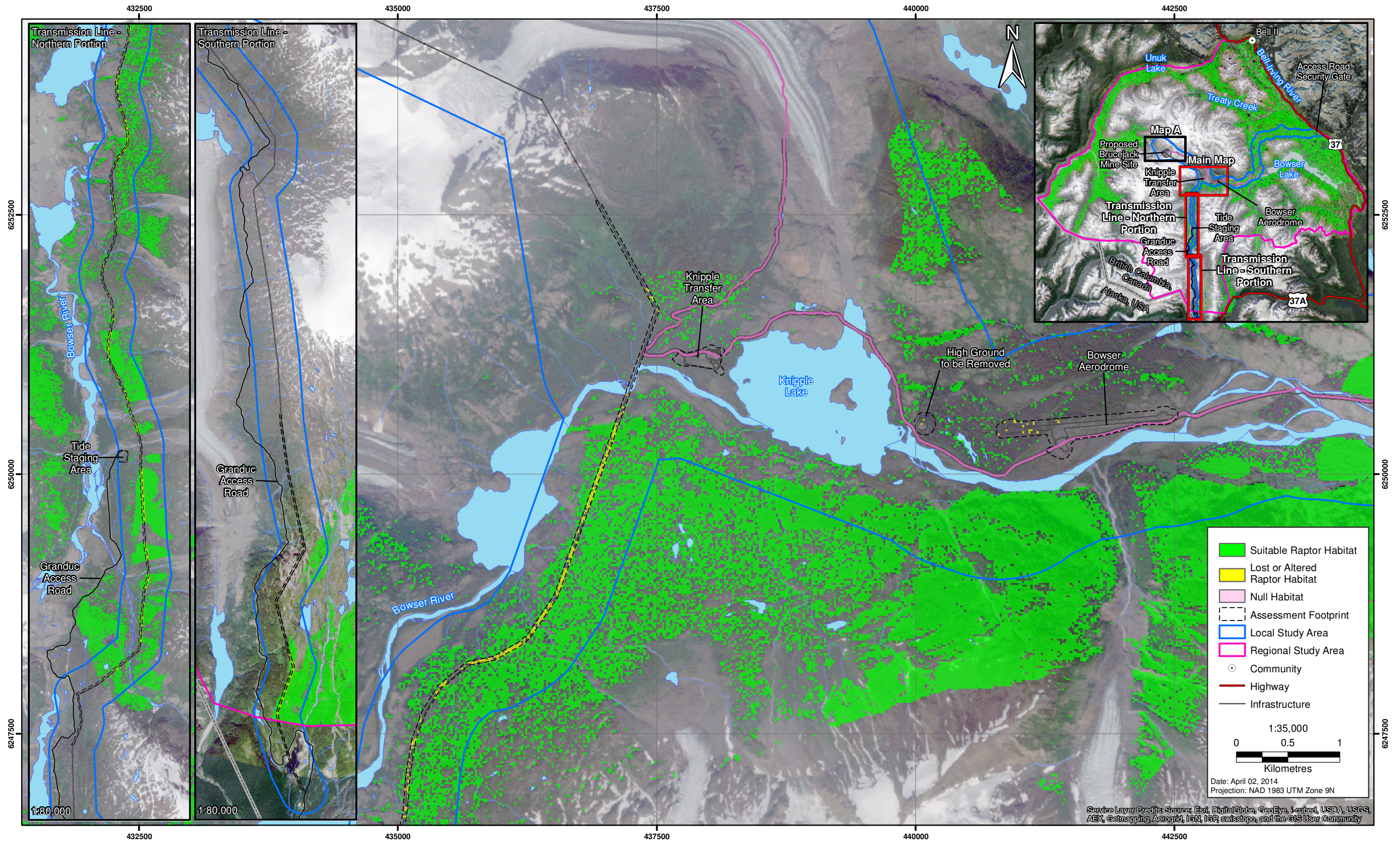
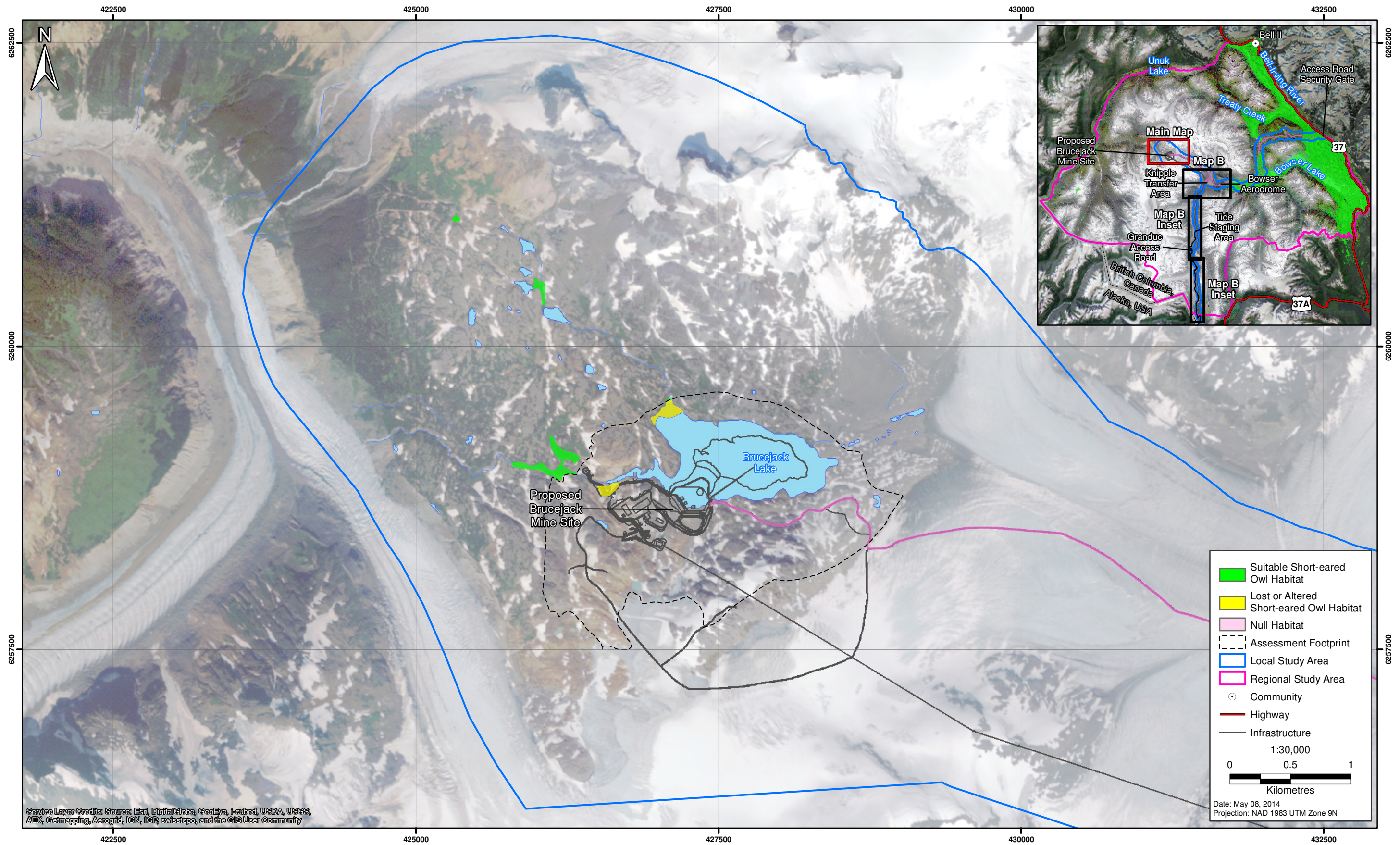
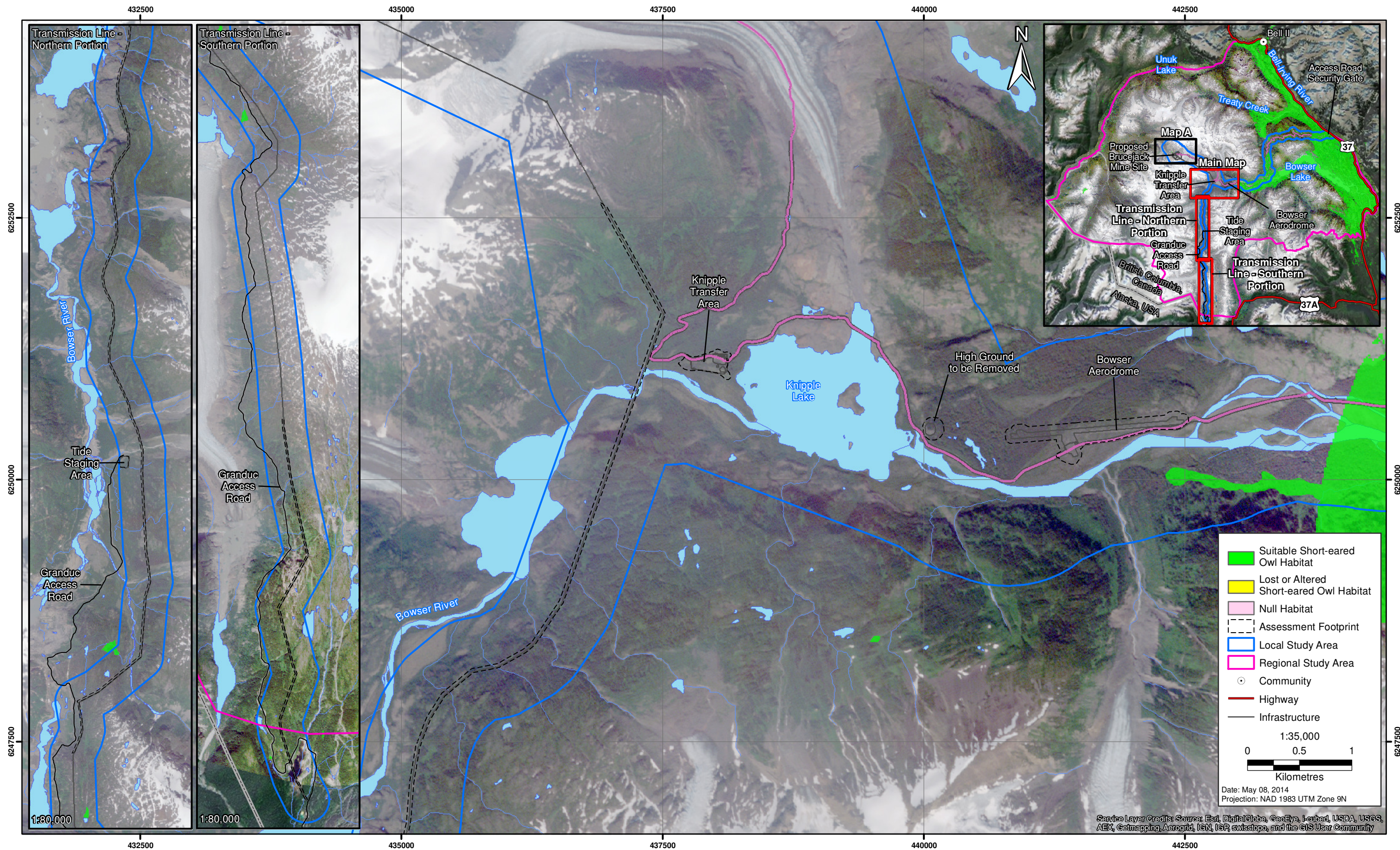


Figure 18.6-18a  
Short-eared Owl Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, IGN, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-18b  
Short-eared Owl Habitat Lost or Altered due to the Project



Noise from blasting, aircraft, and traffic was not assessed. Research has shown that some raptor species appear able to habituate to disturbances. Peregrine falcons are able to nest successfully within a few hundred metres of areas with blasting, construction, quarrying, aircraft activity, and mining operations (Pruett-Jones, White, and Devine 1980; Haugh 1982; White and Thurow 1985; White, Emison, and Bren 1988). Other research on falcons suggest that although they do not habituate, falcons exposed to blasting did not suffer lower productivity (DeLong and Steenhof 2004). In addition, infrequent noises from heavy truck traffic (logging trucks) were reported to have no discernible effect on breeding hawks (Grubb, Pater, and Delaney 1998).

A geographic information system (GIS) analysis was conducted to determine the areas where sensory disturbance may be the most prevalent during Construction and Operation. The total area of suitable nesting habitat was used for the analysis (Section 18.6.7.2). The threshold for raptors was set at 45 dBA; it has been shown that owls can be affected by continuous noise levels at 46 dBA (Delaney et al. 1999). The area of habitat that falls outside of the area of direct habitat lost due to the footprint, but within the threshold noise level contours of 45 dBA or greater, was calculated.

The total area of suitable forest-nesting raptor habitat within the RSA that may be disturbed due to continuous Project noise is 121 ha (0.16% of the RSA, 1.9% of the LSA) during Construction and 90 ha (0.12% of the RSA, 1.5% of the LSA) during Operation (Figures 18.6-19a and 18.6-19b). The majority of Construction disturbance (111 ha) and Operation disturbance (65 ha) will occur along the road from the highway to the aerodrome.

The total area of suitable ground-nesting raptor habitat within the RSA that may be disturbed due to continuous Project noise is 85 ha (0.18% of the RSA, 2% of the LSA) during Construction and 51 ha (0.1% of the RSA, 1.2% of the LSA) during Operation. The majority of Construction disturbance (80 ha) and Operation disturbance (46 ha) will occur along the access road from the highway to the aerodrome.

#### Residual Effects for Raptors due to Sensory Disturbance

Sensory disturbance is not predicted to result in residual effects on forest- or ground-nesting raptors. A total of 0.16 and 0.12% of the suitable habitat for forest nesting raptors within the RSA will be functionally lost due to sensory disturbance from the Construction and Operation phases, respectively. A total 0.18 and 0.11% of the suitable habitat for short-eared owls within the RSA will be functionally lost due to sensory disturbance from the Construction and Operation phases, respectively. Mitigation measures will include clearing surveys and identification of potential nesting habitats, and the application of appropriate buffers around nests, if observed. With mitigation, no residual effects for raptors or short-eared owls due to sensory disturbance during the Construction or Operation phases are anticipated.

#### *18.6.7.4 Direct Mortality*

Potential sources of mortality and injury of raptors can result from collisions with vehicles and destruction of nests during vegetation clearing. Transmission lines can pose a threat to raptors by causing mortality due to collisions and electrocutions from conductors (wires).

#### Vehicle Collisions

Vehicle-raptor collisions are related to locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). Raptors foraging along roadsides or on road kill carcasses increase the potential for collisions, including bald eagles, red-tailed hawks, and short-eared owls (Keran 1981; Moore and Mangel 1996; D. M. Whittington and Allen 2008). Higher vehicle speeds increase the chance of mortality and/or injury to raptors. For example, it has been documented that speeds in excess of 80 km/hour may increase owl-vehicle collisions (D. M. Whittington and Allen 2008).

### Vegetation Clearing

Construction activities could result in direct mortality of raptors through clearing of vegetation actively used for nesting. The habitat selected by forest- and ground-nesting raptors is described in Section 18.6.7.2, as well as a quantitative analysis of the amount that will be cleared during Construction and Operation. The *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) specifically protects birds, their nests, and their eggs from possession, molestation, or destruction. Therefore, mitigation measures will be implemented including timing of vegetation clearing and pre-construction surveys as required.

### Transmission Line

The Brucejack Transmission Line will connect to the provincial power grid at the Long Lake Hydro Project. The 55-km transmission line from the Long Lake Hydro Project near Stewart to the Brucejack Mine Site may pose a threat to raptors through collisions, electrocutions, or nest building. The frequency of collisions with transmission line infrastructure increases with poor weather and reduced visibility, or if infrastructure is located in regularly used areas (e.g., migration corridors, approach flyways to nests). The majority of bird collisions occur in specific habitats, including next to wetlands (Bevanger 1998), between resting and foraging areas (Savereno et al. 1996), near and parallel to shores (Cooper and Day 1998), in valleys and river valleys (Bevanger 1998; M. Moritzi et al. 2001), and along ridge lines where soaring birds congregate on thermal updrafts (Barrios and Rodriguez 2004). Birds with poor manoeuvrability are the most susceptible to collisions, including raptor species with large wingspans or juveniles that have not yet mastered the flight capabilities of adults (Bevanger 1998).

Raptors may use transmission line infrastructure for nest building or for perching on insulators, energized equipment (transformers), and/or between conductors. The Brucejack Transmission Line will be constructed using best management guidelines presented by the Avian Power Line Interaction Committee (APLIC 2012b) to minimize any effects on raptors. The mitigation by design may include spacing between conductors greater than 1.5 m, reduction in perching opportunities, and designs to minimize the attraction to build nests. Large distances between transmission towers may increase collisions with conductors. Marking existing conductors by using markers, such as flapper-type diverters or aerial marker balls, will increase the visibility and reduce collisions. The use of the Project infrastructure by perching raptor species will be monitored. The Brucejack Transmission Line will also be monitored for nesting activity and managed adaptively if high-use areas are identified. Where required, the relevant government agency will be contacted on a case-by-case basis in order to determine how to manage bird nests that are built on Project infrastructure.

### Residual Effects for Raptors due to Direct Mortality

Direct mortality is not expected to result in a residual effect for raptors. Mitigation measures will include limiting speeds of vehicular traffic that will greatly reduce the potential for mortality of raptors, as speed limits along the access road will be lower than 80 km/hour (maximum of 40 km/hour). Any potential road kill will be removed to deter scavenging by raptors. The effect of direct mortality due to vehicle-raptor collisions is not anticipated to result in a residual effect on raptors.

Pre-clearing surveys for active nests would be conducted before clearing if development activities take place during the breeding season (April 1 to July 31; Section 18.6.7.2). With mitigation, a residual effect of direct mortality due to vegetation clearing is not anticipated.

Figure 18.6-19a  
 Functional Loss of Habitat for Raptors due to Noise – Construction

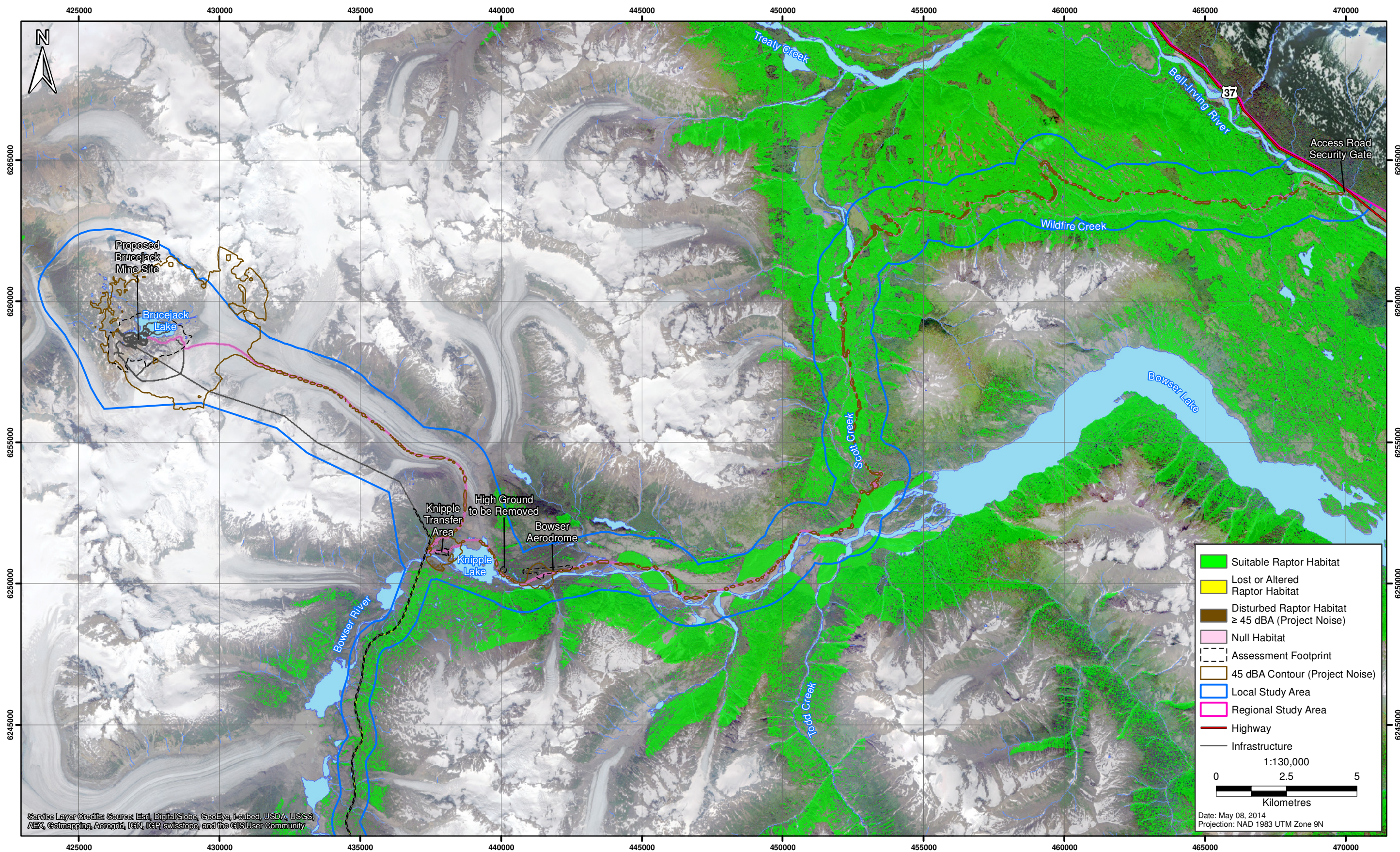
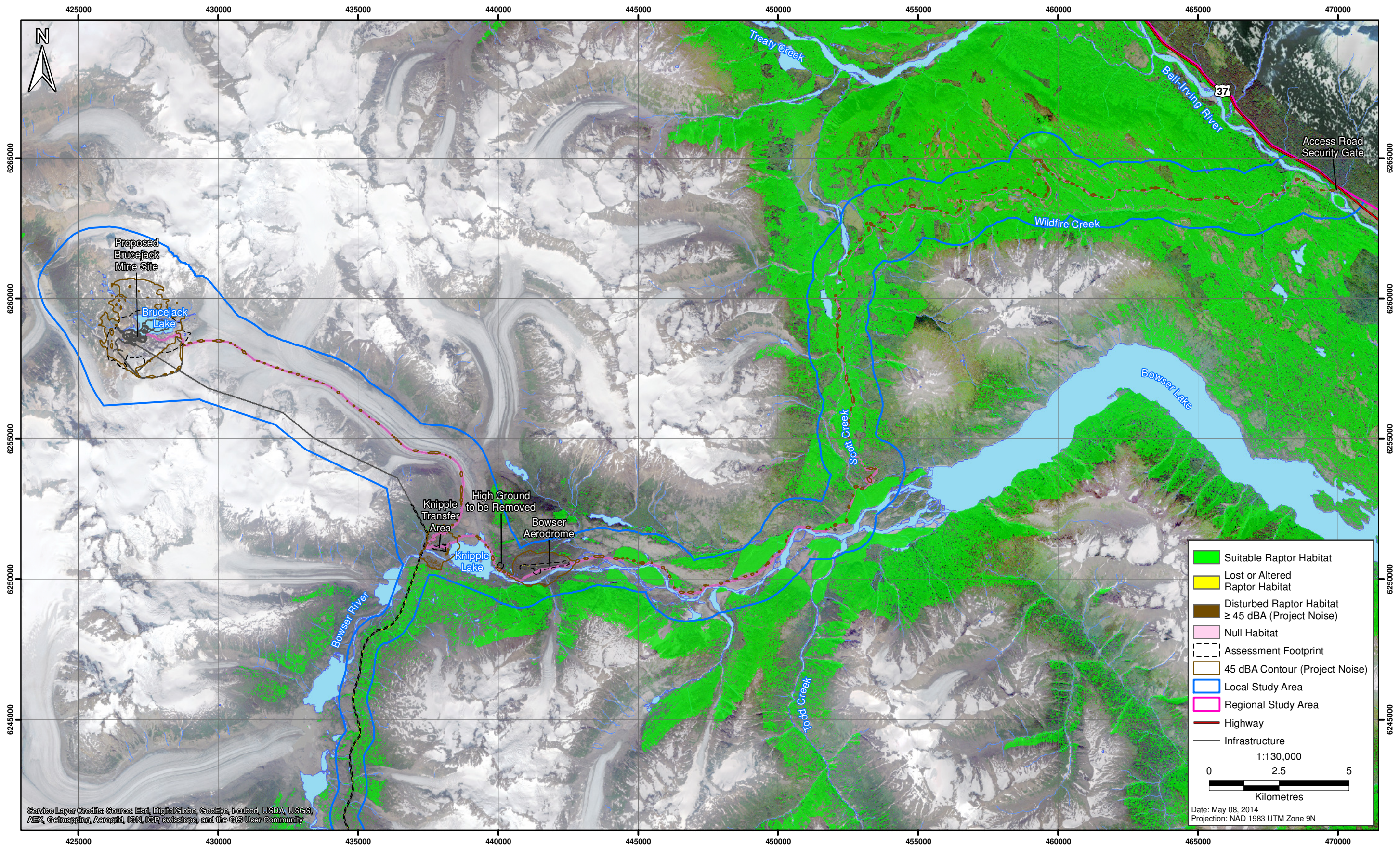


Figure 18.6-19b  
 Functional Loss of Habitat for Raptors due to Noise – Operation



The frequency of bird electrocutions and collisions with the transmission lines and structures is expected to be rare and is not expected to negatively affect local populations. Some mortality due to collisions is possible, particularly in high-use areas such as near large waterbodies, wetlands, or gullies. However, with mitigation, no residual effect of direct mortality due to transmission lines for raptors is anticipated.

#### 18.6.7.5 *Attractants*

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that may draw wildlife to interact with the Project. Raptors are primarily attracted to developments in the following ways: 1) attraction to prey species that are attracted to domestic food waste; 2) attraction to carrion at road kill sites; and 3) attraction to structures for perching and/or nesting.

In natural habitats, peregrine falcons, gyrfalcons, and rough-legged hawks nest on ledges and precipitous cliff faces. In landscapes with human-made structures, cliff-nesting birds nest on ledge-like features such as cairns, towers, bridges, and pit walls. The transmission line towers may also provide perches and nesting habitat for tree-nesting raptors (APLIC 2006). Red-tailed hawks are frequently seen perching on utility poles watching for prey (Preston and Beane 1993). Ospreys are known to use transmission line structures for nesting purposes more than any other North American raptor (APLIC 2006). Effects of direct mortality due to electrocution and associated mitigation are listed in Section 18.6.7.4.

#### Residual Effects for Raptors due to Attractants

Attractants are not anticipated to result in a residual effect on raptors. Once mitigation measures for proper domestic waste storage and incineration have been implemented, raptors are not expected to be attracted to waste sites. Eagles may be attracted to roadsides with a relatively high density of road kill, which may increase the potential for collisions of these raptors with vehicles (D. M. Whittington and Allen 2008). This potential effect will be reduced by limiting speeds and the removal of any road kill from access roads. Thus, raptors are not expected to be attracted to roadsides. The transmission line towers may also provide perches and nesting habitat for tree-nesting raptors, attracting raptors to the transmission line (APLIC 2012b). Effects of attraction and associated mitigation by design are addressed in the direct mortality Section 18.6.7.4; this mitigation will minimize the attraction to infrastructure and will not result in a residual effect. Overall, no residual effect due to attraction is anticipated for raptors.

### 18.6.8 **Potential Residual Effects on Migratory Waterbirds**

#### 18.6.8.1 *Identifying Key Effects*

Migratory waterbirds were assessed for potential Project related effects. Habitat loss and alteration, sensory disturbance, direct mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on migratory waterbirds. The effects of disruption of movement and indirect mortality were scoped out of this assessment because they were determined to have no interaction with waterbirds. The potential residual effects considered in the assessment for migratory waterbirds are summarized in Table 18.6-12, and described in the following sections, from Section 18.6.8.2 to 18.6.8.6.

#### 18.6.8.2 *Habitat Loss and Alteration*

The RSA supports at least 28 different species of waterbirds (Appendix 18-A, 2013 Wildlife Characterization Baseline Report). Potential effects due to direct habitat loss and alteration on waterbirds were considered because species in this group are afforded protection under the *Migratory Birds Convention Act* (1994). The nests and eggs of waterbirds are afforded protection under the *BC Wildlife Act* (Pahlke, McPherson, and Marshall 1996).

**Table 18.6-12. Ranking Potential Effects on Migratory Waterbirds**

Project Components/ Physical Activities	Potential Effects on Migratory Waterbirds						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	○	○	○	○
Access Road	○	●	○	●	○	○	○
Transmission Line	●	○	○	●	○	○	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	○	○	●	○
Access Road	○	●	○	●	○	○	○
Transmission Line	○	○	○	●	○	○	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	○	○	○	○	○	○
Access Road	○	○	○	●	○	○	○
Transmission Line	○	○	○	●	○	○	○

**Notes:**

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

Three groups of waterbirds that occupy different types of habitat have been observed in the RSA during baseline studies: (1) wetland birds, (2) cavity-nesting waterfowl, and (3) riverine birds. Wetland birds (e.g., dabbling ducks, geese) occupy lakes, swamps, marshes, and shallow open-water wetlands. Cavity-nesting waterfowl (e.g., common goldeneye) occupy mature forested areas, usually within 1 km of suitable wetlands. Riverine birds (e.g., harlequin duck) occupy montane rivers and streams. Habitat loss and alteration assessments were conducted separately for each of these three waterbird groups.

Waterbird Habitat Requirements and Availability

During spring and fall migrations, the highest concentrations of avifauna were observed in calm, low-flowing waterbodies within the RSA along the Bell-Irving River, Treaty Creek, Bowser River, and the lower Unuk River.

Wetland birds typically breed in nests constructed along the edges of waterbodies such as wetlands, marshes, or lakes. Nests are commonly concealed in grasses, clumps of emergent vegetation such as cattails and bulrush, or under riparian vegetation (Campbell et al. 1990). Mallards may nest on the ground up to several hundred metres from water.

Cavity-nesting species, such as bufflehead and mergansers, may nest up to 800 m from water in forested habitat (Pierre, Bears, and Paszkowski 2001). Goldeneyes may nest up to 1.3 km from water (Eadie, Mallory, and Lumsden 1995). Suitable cavities for these species occur in mature and old-growth forest with large trees near water (Campbell et al. 1990). Harlequin ducks, a riverine bird, were observed in pairs along sections of the Bowser River and upper Sulphurets Creek in the LSA (Appendix 18-A, 2013 Wildlife Characterization Baseline Report). They generally build their nests on the ground in riparian areas on mid-stream islands (Robertson and Goudie 1999).

Suitable habitat for migrating and breeding waterbirds was identified within the RSA as lakes, wetlands, marshes, swamps, and shallow open-water wetlands. Suitable habitat for cavity-nesting waterfowl was identified as riparian areas and mature forested habitat within 1 km of an appropriate waterbody (lakes, marshes, swamps, and shallow open-water wetlands). Suitable habitat for riverine birds was identified as rivers and streams of order two and larger. Suitable riparian habitat along streams was measured in terms of length (km) rather than area.

Waterbirds were not observed using Brucejack Lake during breeding or staging periods during baseline studies. Incidental duck sightings were recorded on Brucejack Lake; however, it is likely unsuitable for foraging or nesting because of the short growing season for vegetation, extensive period which it is covered with ice, and because it is oligotrophic (i.e., very little to no aquatic vegetation or other organisms; Chapter 14, Assessment of Potential Aquatic Resources Effects). Therefore, Brucejack Lake is not included in the calculations of available habitat for wetland birds, as it is not considered suitable habitat.

**Wetland Bird Habitat Availability:** Within the RSA, 9,048 ha of wetlands were considered suitable for wetland birds, with 831 ha within the LSA (Figures 18.6-20a and 19.6-20b). The majority of suitable wetland bird habitat within the LSA was modelled along Bowser River and Knipple Lake.

**Cavity-nesting Waterfowl Habitat Availability:** Within the RSA, 57,135 ha of suitable cavity-nesting waterfowl habitat was identified, and 6,109 ha within the LSA (Figure 18.6-19a, 18.6-19b). The majority of suitable cavity-nesting habitat within the LSA was modelled along Bowser River.

**Riverine Bird Habitat Availability:** Overall, 506 km of suitable riverine bird habitat were identified in the RSA, and 60 km were identified in the LSA (Figures 18.6-20a, 18.6-20b). The majority of suitable riverine bird habitat within the LSA was modelled along the Bowser River.

#### Waterbird Habitat Loss and Alteration

An analysis was conducted to determine the magnitude of habitat loss and alteration for locally breeding wetland birds, cavity-nesting waterfowl, and riverine birds in the RSA and LSA. The total area of suitable habitat lost or altered (i.e., Project footprint and buffers) within this boundary was calculated. Habitat loss and alteration for all waterbirds in the RSA is summarized in Table 18.6-13.

**Table 18.6-13. Wetland Bird, Cavity-nesting Waterfowl, and Riverine Bird Habitat Loss and Alteration due to the Project**

Waterbird Group	Habitat Lost and Altered (ha)	Regional Study Area		Local Study Area	
		Total Habitat Available (ha)	Habitat Lost/ Altered (%)	Total Suitable Habitat (ha)	Habitat Lost/ Altered (%)
Wetland birds	2.3	9,048	0.02	831	0.27
Cavity-nesting waterfowl	41.7	57,135	0.07	6,109	0.68
Riverine birds <sup>1</sup>	0.8 km	506 km	0.16	60 km	1.37

<sup>1</sup> Area of lost or altered is given in length of stream (km) rather than area.

**Wetland Bird Habitat Loss and Alteration:** A total of 2.3 ha of wetland bird habitat will be lost or altered (i.e., Project footprint and buffers) due to the Project during the Operation phase (Table 18.6-13; Figures 18.6-20a, 18.6-20b). This area lost represents 0.02% of the suitable wetland habitat available in the RSA and 0.27% in the LSA (Table 18.6-13). The majority of wetland loss will occur within the mine site assessment footprint (2.0 ha); the remaining wetland loss will be along the Brucejack Transmission Line (0.3 ha; Figure 18.6-20b).

**Cavity-nesting Waterfowl Habitat Loss and Alteration:** For cavity-nesting waterfowl, the loss or alteration (i.e., Project footprint and buffers) of mature forest within 1 km of wetlands was calculated. A total of 41.7 ha of suitable cavity-nesting habitat will be lost due to the Project during the Operation phase (Table 18.6-13). This represents approximately 0.07% of available habitat within the RSA and 0.68% in the LSA. The majority (96%; 40.1 ha) of cavity-nesting habitat will be lost due to the Brucejack Transmission Line (Figures 18.6-21a and 18.6-21b). This habitat type will not be lost or altered within the mine site assessment footprint.

**Riverine Bird Habitat Loss and Alteration:** A total of 0.8 km of suitable riverine habitat will be lost or altered (i.e., Project footprint and buffers) due to Project development during the Operation phase (Table 18.6-13). The total lost or altered habitat represents 0.16% of available riverine habitat in the RSA and 1.37% in the LSA (Figures 18.6-22a and 18.6-22b). The majority of this habitat is within the mine site assessment footprint (61%); the remaining habitat is along the Brucejack Transmission Line (34%) and at the Tide Staging Area (5%).

#### Residual Effects for Migratory Waterbirds due to Habitat Loss and Alteration

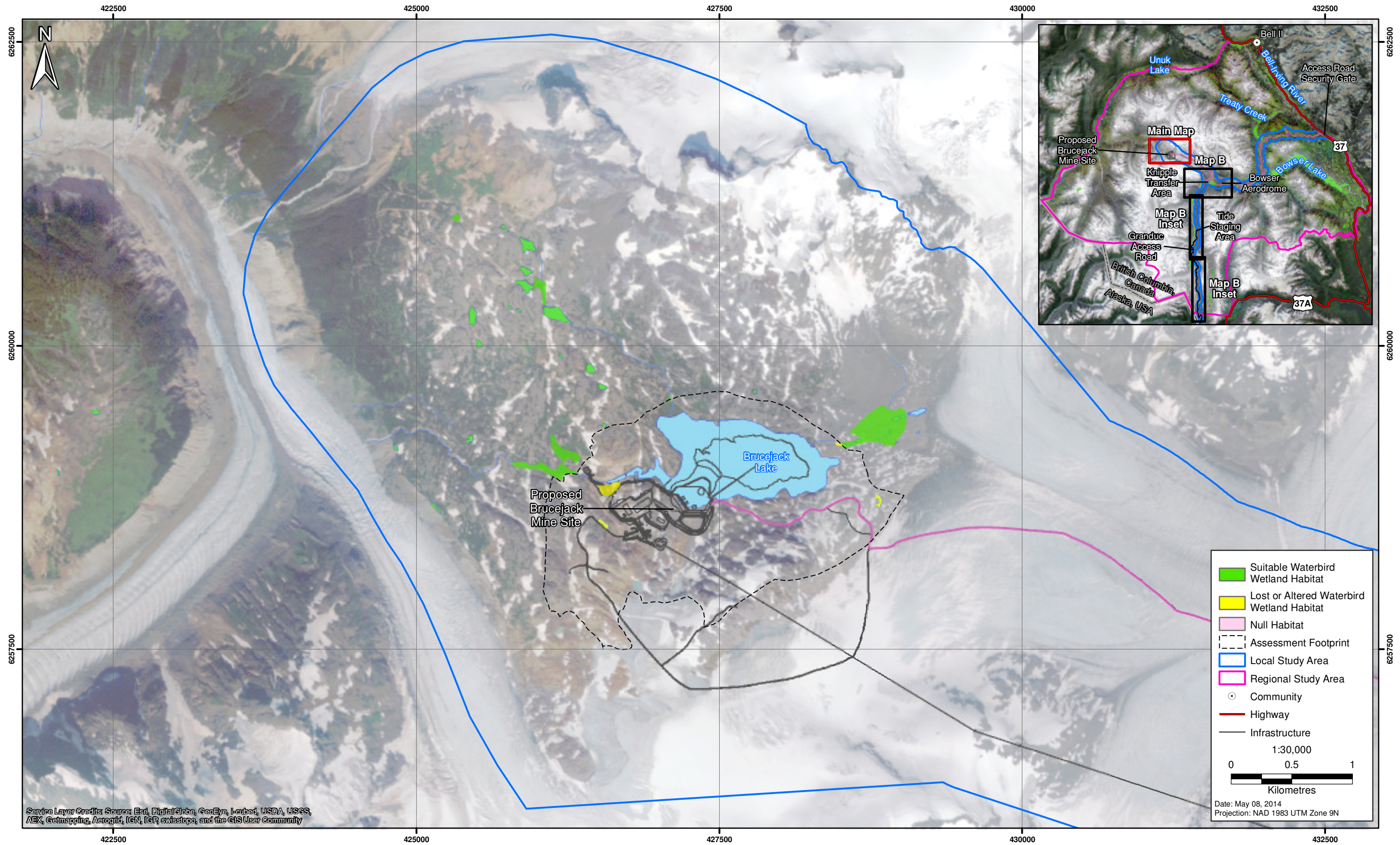
The effect of habitat loss and alteration is not predicted to result in a residual effect for migratory waterbirds. Waterbird habitat loss and alteration will occur within the RSA and LSA; however, the loss is minimal (less than 0.3% suitable habitat within the RSA). Mitigation would include avoiding active waterbird nests by conducting clearing outside breeding periods (April 1 to July 31) or through pre-construction surveys for nests in suitable habitat when clearing is required within the breeding period. If waterbird nests are found during the pre-construction surveys, an undisturbed buffer area would be established around nests. If it is necessary to work within the buffer during the breeding season, surveys will be conducted to ensure no nests will be impacted. After mitigation, no residual effects for waterbird habitat loss or alteration are anticipated.

#### *18.6.8.3 Sensory Disturbance*

A potential source of waterbird sensory disturbance associated with the Project includes elevated noise levels due to Project construction and operation. The potential consequences of disturbance include functional loss of habitat due to avoidance, increased energetic costs due to decreased foraging time and increased flying time, nest abandonment and increased predation rates, and reduced reproductive success (Hockin et al. 1992).

A GIS analysis was conducted to determine the amount of wetland, cavity-nesting, and riverine habitat that could be functionally lost or disturbed due to Project and traffic noise averaged throughout the day. When analyzing increased noise levels due to the Project, a 45 dBA Ln noise contour was used. The area of waterbird habitat that falls within the 45 dBA noise modelling contours was calculated; waterbird habitat lost due to infrastructure was not included in these calculations, as they were considered in Section 18.6.8.2.

Figure 18.6-20a  
Wetland Bird Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, IGN, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-20b  
Wetland Bird Habitat Lost or Altered due to the Project

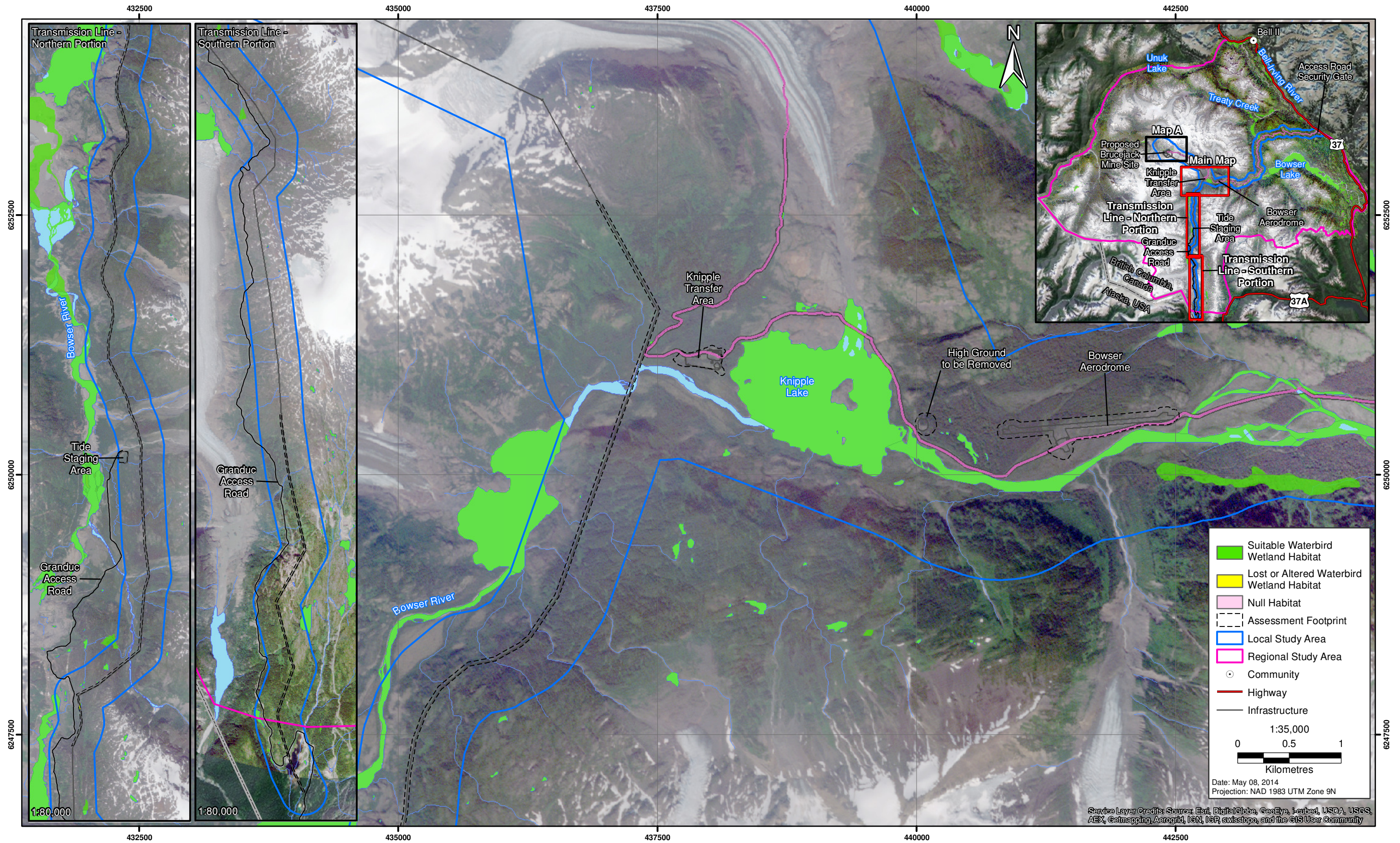
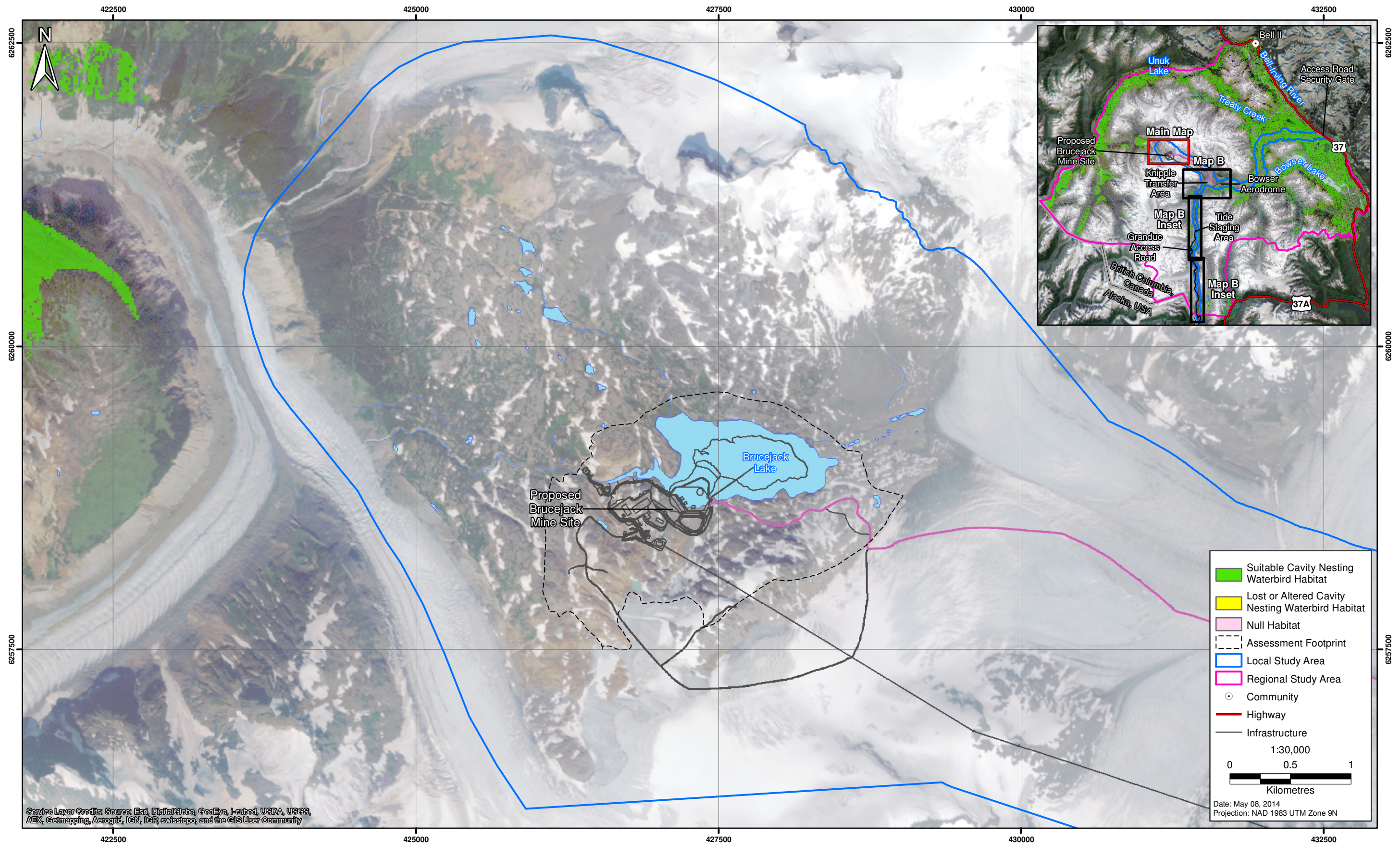


Figure 18.6-21a  
Cavity-nesting Waterfowl Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-21b  
Cavity-nesting Waterfowl Habitat Lost or Altered due to the Project

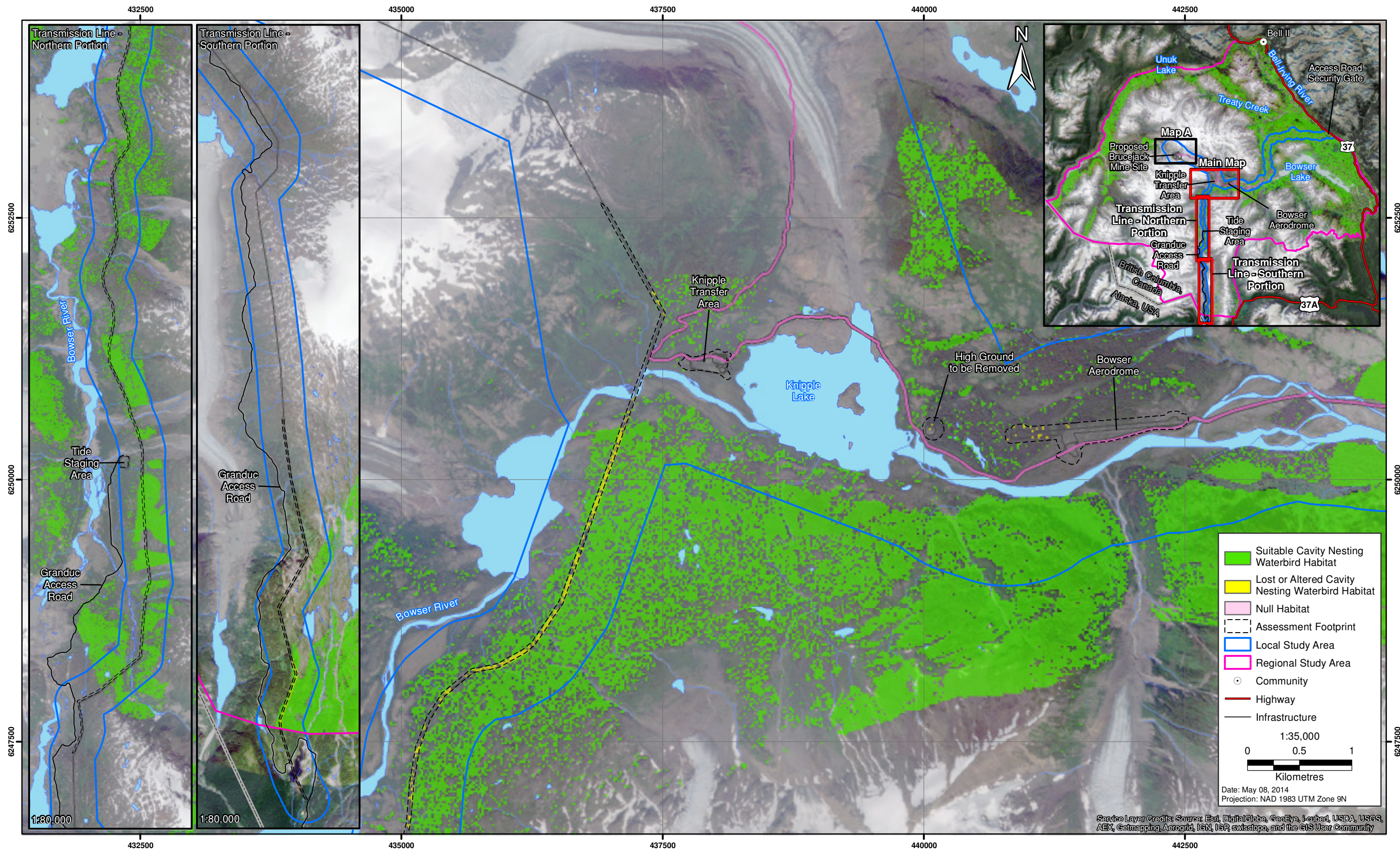
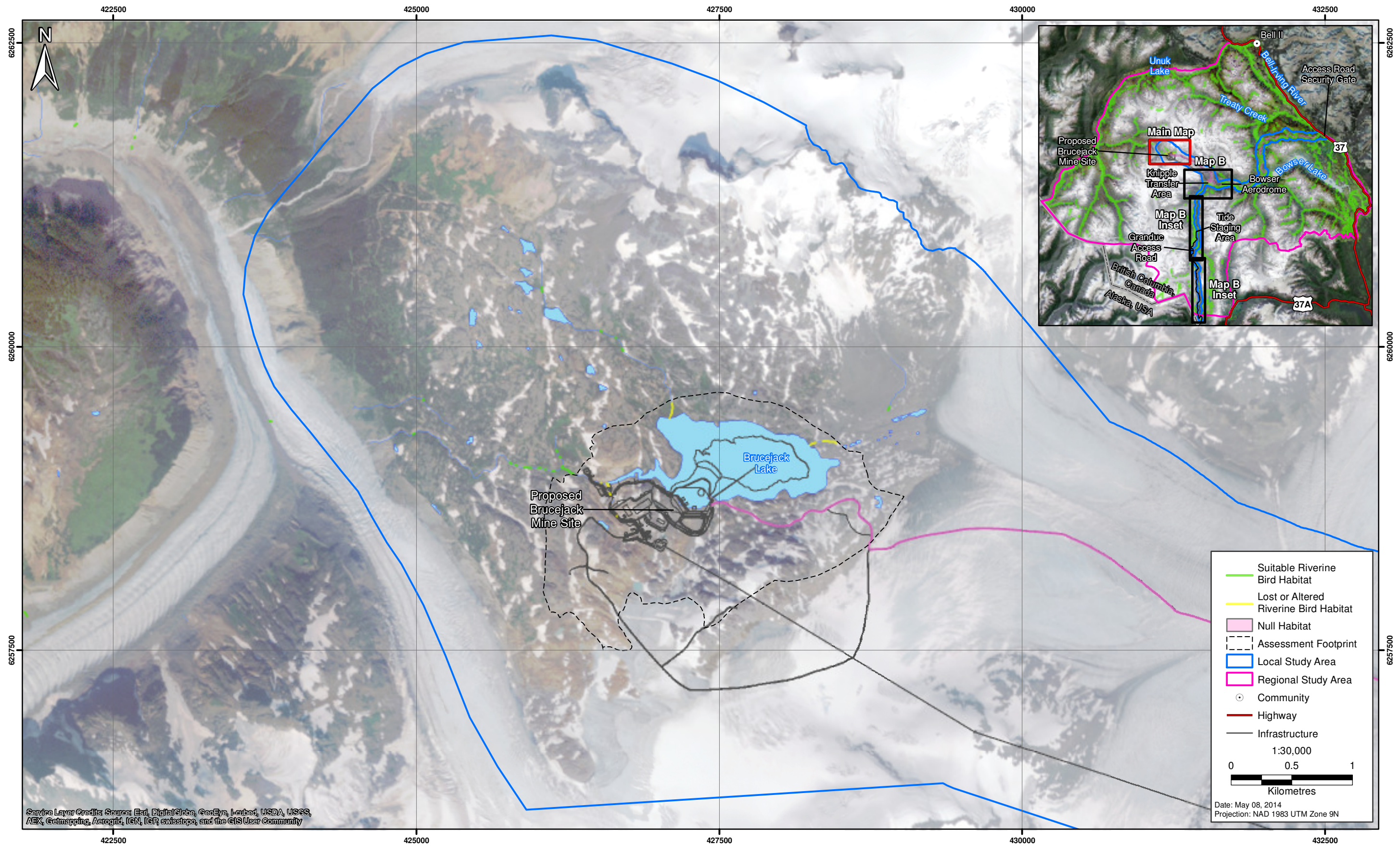
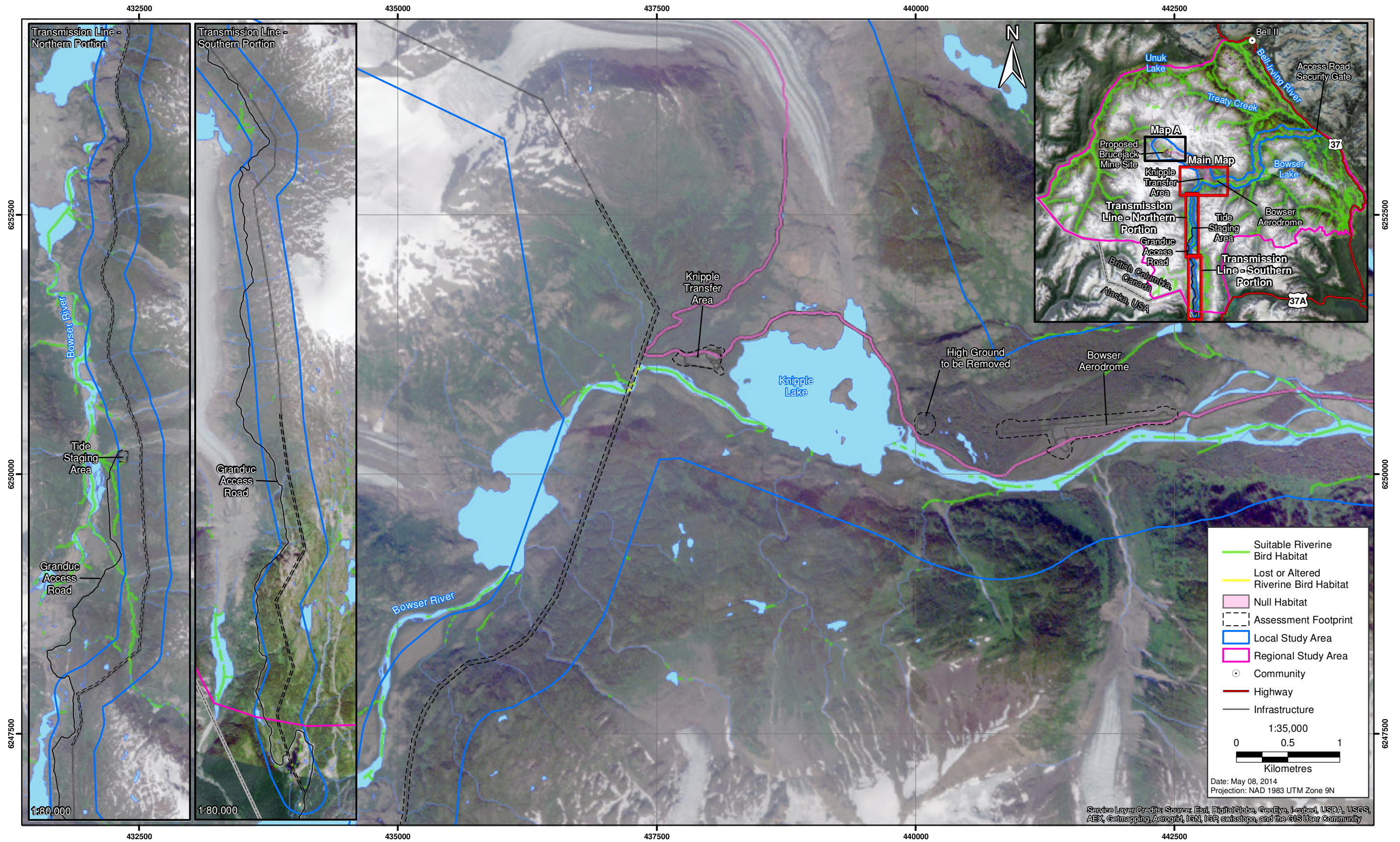


Figure 18.6-22a  
Riverine Bird Habitat Lost or Altered due to the Project



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Figure 18.6-22b  
Riverine Bird Habitat Lost or Altered due to the Project



**Wetland Birds:** The total wetland area that will be functionally lost or disturbed as wetland bird habitat within the 45 dBA and greater sound contour is 41 ha (0.5% of the RSA, 5% of the LSA) during Construction and 51 ha (0.6% of the RSA and 6% of the LSA) during Operation (Table 18.6-14; Figures 18.6-23a and 18.6.23b). The majority of the area affected during Construction is the Knipple Transfer Area, Bowser Aerodrome, and Brucejack Mine Site, while the majority of disturbance during Operation will be associated with the Bowser Aerodrome and Knipple Transfer Area.

**Table 18.6-14. Functional Loss of Suitable Wetland Bird, Cavity-nesting Waterfowl, and Riverine Bird Habitat due to Sensory Disturbance during Construction and Operation**

Waterbird Group	Project Phase	Project Noise (45 dBA)		
		Functional Habitat Lost	Suitable Habitat <sup>1</sup> Lost (%)	
			Regional Study Area	Local Study Area
Wetland bird	Construction	41 ha	0.5	4.9
	Operation	51 ha	0.6	6.2
Cavity-nesting waterfowl	Construction	121 ha	0.2	2.0
	Operation	90 ha	0.2	1.5
Riverine bird <sup>2</sup>	Construction	2 km	0.4	3.3
	Operation	3 km	0.6	5.1

<sup>1</sup> Suitable habitat refers to high-quality habitat in the RSA and LSA; see text for definition of high-quality habitat.

<sup>2</sup> Area of functional habitat lost is given in length of stream (km) rather than area.

**Cavity-nesting Waterfowl:** The total area of cavity-nesting habitat that will be functionally lost or disturbed within the 45 dBA and greater sound contour is 121 ha (0.2% of the RSA, 2% of the LSA) during Construction and 90 ha (0.2% of the RSA and 1.5% of the LSA) during Operation (Table 18.6-14; Figures 18.6-24a and 18.6-24b). The majority of the disturbed habitat during Construction and Operation is associated with the access road between Highway 37 and the Bowser Aerodrome.

**Riverine Birds:** The total length of riverine habitat that will be functionally lost or disturbed within the 45 dBA and greater sound contour is 2 km (0.4% of the RSA, 3.3% of the LSA) during Construction and 3 km (0.6% of the RSA, 5.1% of the LSA) during Operation (Table 18.6-14; Figures 18.6-25a and 18.6-25b). The majority of the disturbance will occur near the Bowser Aerodrome and Knipple Transfer Area during both Construction and Operation.

#### Residual Effects for Migratory Waterbirds due to Sensory Disturbance

The effect of sensory disturbance is not anticipated to result in a residual effect on migratory waterbirds. The extent of the wetlands, cavity-nesting habitat, and riverine habitat that are considered functionally lost or disturbed due to noise is less than 1% of the available habitat in the RSA for any group regardless of the Project phase (Table 18.6-14). Waterbirds within disturbed areas may flush or avoid habitat due to visual and noise disturbance, which could be detrimental during the breeding period. Due to the small area of disturbed habitat, no residual effect of sensory disturbance on migratory waterbirds is anticipated.

#### 18.6.8.4 Direct Mortality

The potential sources of migratory waterbird mortality in association with the Project are nest destruction during clearing operations and collisions with the Brucejack Transmission Line.

### Vegetation Clearing

Construction activities could result in direct mortality of waterbirds through clearing of vegetation that is actively used for nesting. The habitat selected by nesting birds is described in Section 18.6.8.2, as well as a quantitative analysis of the amount that will be cleared. The *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) specifically protects birds, their nests, and their eggs from possession, molestation, or destruction. Therefore, mitigation measures will be implemented that include timing of vegetation clearing and pre-construction surveys as required.

### Transmission Line

Direct mortality of waterbirds from collisions with or electrocutions by transmission lines can occur, but is a relatively rare occurrence. The risk of mortality when waterbirds collide with transmission lines is primarily based on the type of line and the configuration of electrical hardware and support structures (Lehman, Kennedy, and Savidge 2007). The majority of collisions with transmission lines occur in specific habitats such as next to wetlands (Bevanger 1998), between resting and foraging areas (Savereno et al. 1996), near and parallel to shores (Cooper and Day 1998), in valleys and river valleys (Bevanger 1998; Martin Moritzi et al. 2001), and along ridge lines where soaring birds congregate on thermal updrafts (Barrios and Rodriguez 2004). Poor weather and visibility may increase the frequency of collisions, particularly in regularly used areas (e.g., migration corridors, approach flyways to nests; Bevanger 1998). Waterfowl are sensitive to collisions with transmission lines because of their poor manoeuvrability (Bevanger 1998; Cooper and Day 1998; Martin Moritzi et al. 2001; Erickson, Johnson, and Young Jr 2005; Barrett and Weseloh 2008). Juvenile species that have not yet mastered the flight capabilities of adults are also at a greater risk of transmission line collisions (Bevanger 1998).

Waterbirds may use transmission line infrastructure for nest building, or for perching on insulators, energized equipment (transformers), and/or between conductors. This attraction may increase the possibility of electrocution, although waterbirds use transmission line structures less typically than raptors. Frequent perching on insulators can lead to the accumulation of bird guano, known as streaming. Streaming inhibits the insulation qualities, causing an electrical fault; although mortality due to this is a rare occurrence, it is possible (Vosloo 2009).

### Residual Effects for Migratory Waterbirds due to Direct Mortality

The effect of direct mortality is not anticipated to result in a residual effect on waterbirds. The mitigation proposed to limit the effects of habitat loss (Section 18.6.8.2) for waterbirds will assist in lessening the potential for direct mortality effects. Pre-clearing surveys for active nests would be conducted before clearing if development activities take place during the breeding season (April 1 to July 31; Section 29.21, Wildlife Management and Monitoring Plan). In addition, transmission line designs will follow established guidelines for bird protection (APLIC 2012a). The frequency of bird electrocutions and collisions with the Project transmission lines and structures is expected to be rare and not adversely affect local populations. Some mortality due to collisions with vehicles and the transmission line is possible, particularly in high-use areas such as near large waterbodies, wetlands, or gullies, but this mortality is not expected to adversely affect the population. Thus, no residual effect of direct mortality for waterbirds is anticipated.

#### *18.6.8.5 Attractants*

A potential attractant source for waterbirds is Brucejack Lake. Natural waterbodies are important foraging, staging, and breeding habitat for waterbirds; however, many species will use sewage treatment ponds and other man-made waterbodies (Campbell et al. 1990). However, Brucejack Lake was not identified as being suitable habitat for waterbirds and no sewage treatment ponds are to be constructed for the Project.

Figure 18.6-23a  
 Functional Loss of Suitable Habitat for Wetland Birds due to Noise – Construction

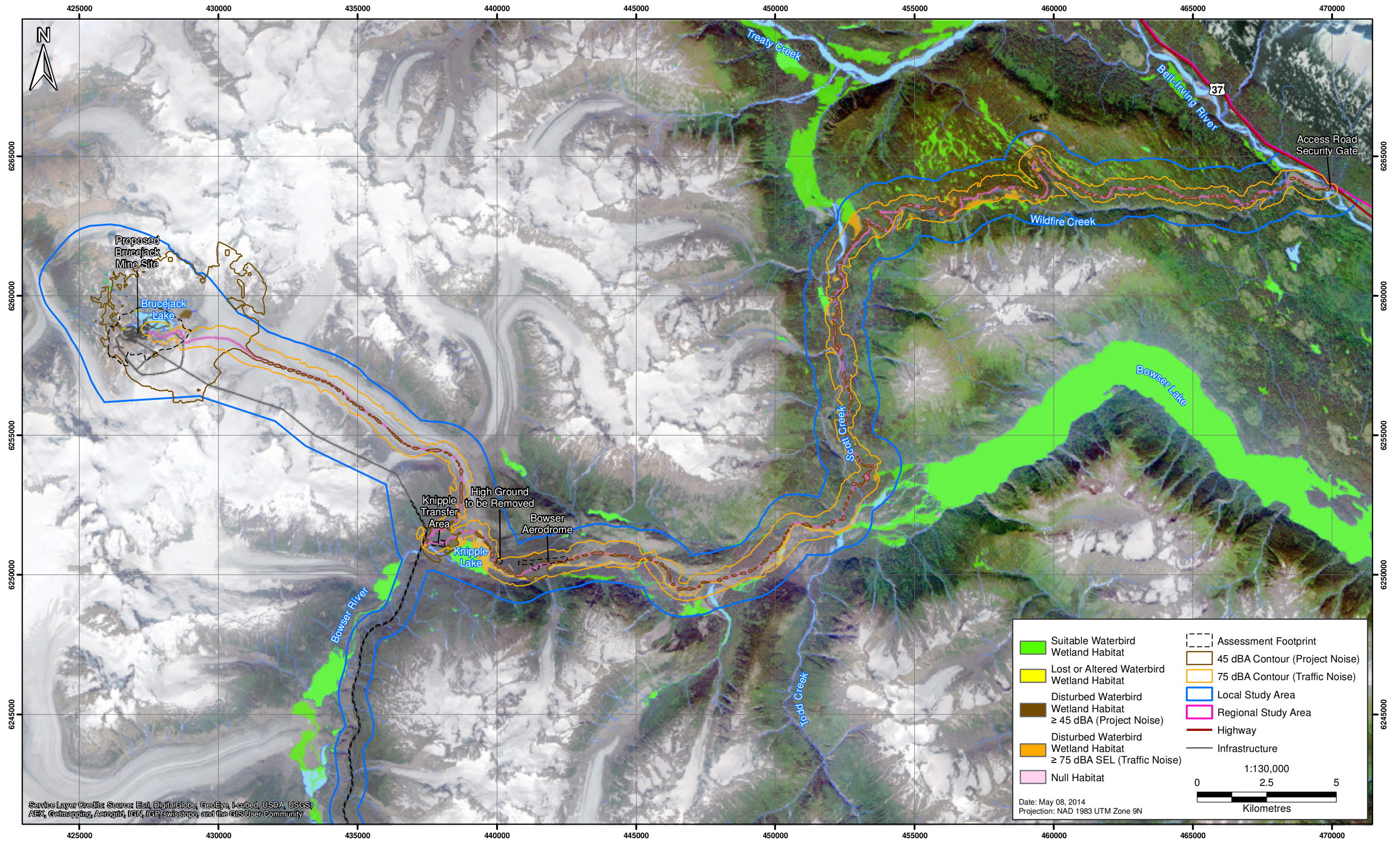


Figure 18.6-23b  
 Functional Loss of Suitable Habitat for Wetland Birds due to Noise – Operation

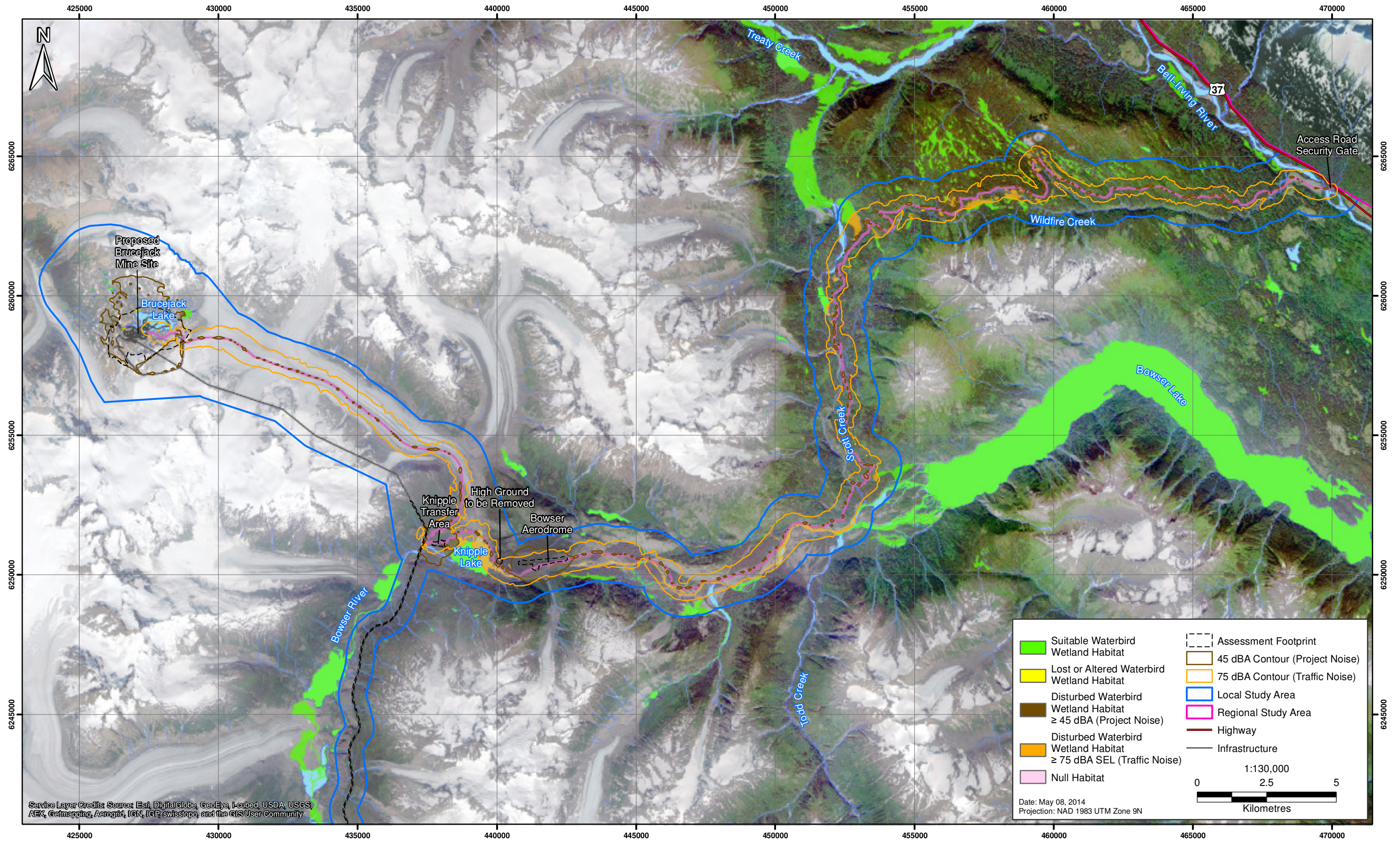
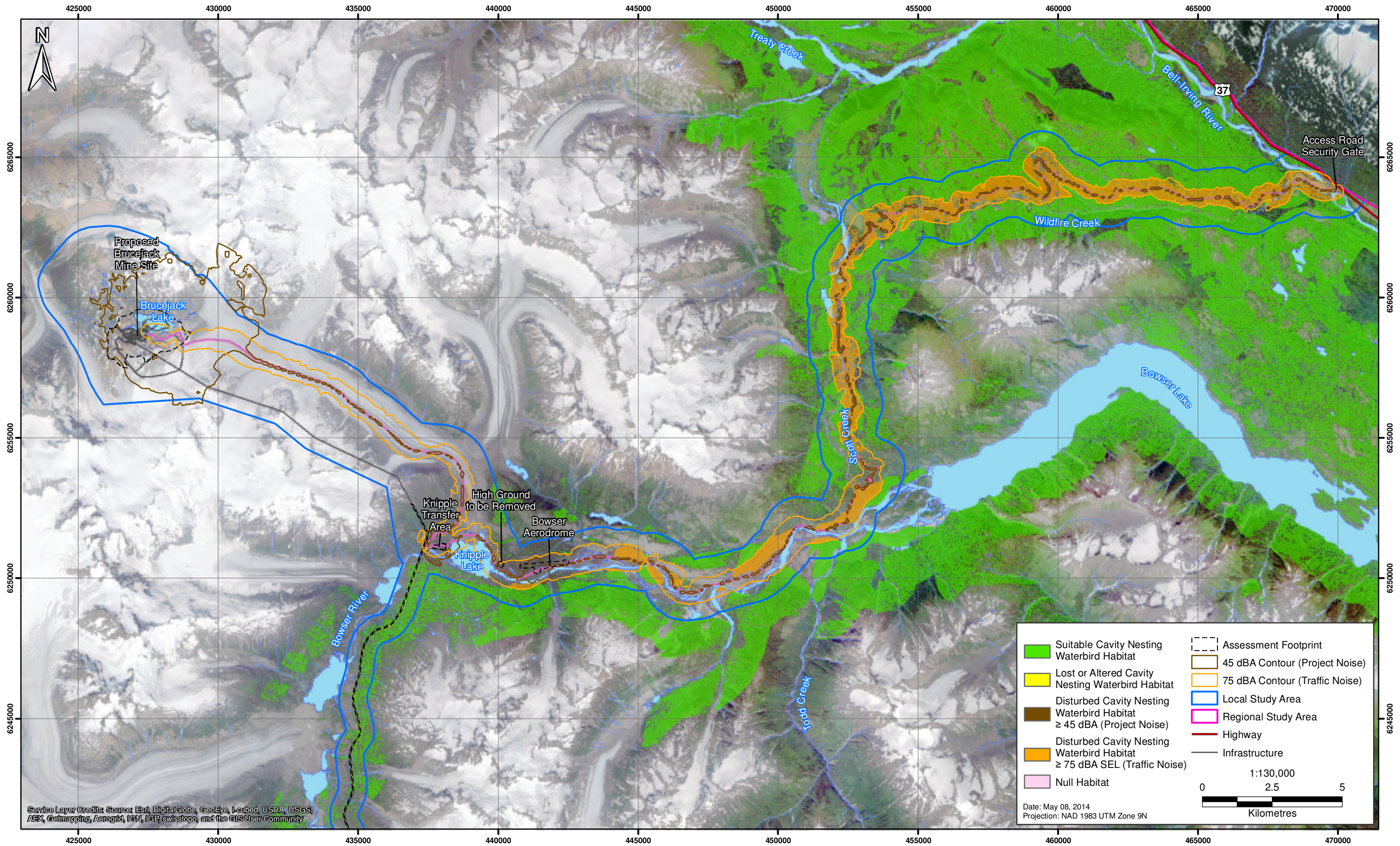


Figure 18.6-24a  
 Functional Loss of Suitable Habitat for Cavity-nesting Waterfowl due to Noise – Construction



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Figure 18.6-24b  
 Functional Loss of Suitable Habitat for Cavity-nesting Waterfowl due to Noise – Operation

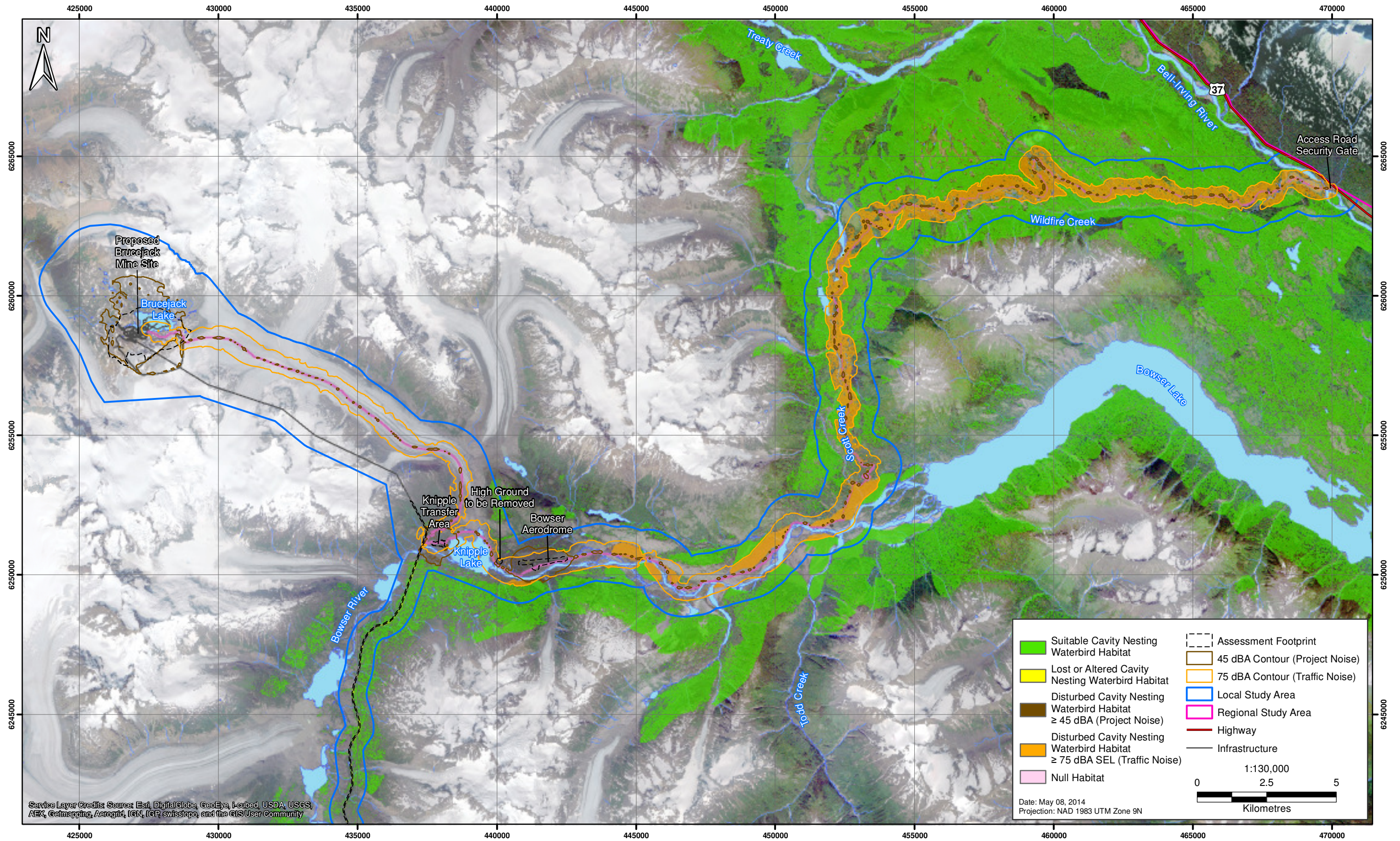


Figure 18.6-25a  
 Functional Loss of Suitable Habitat for Riverine Birds due to Noise – Construction

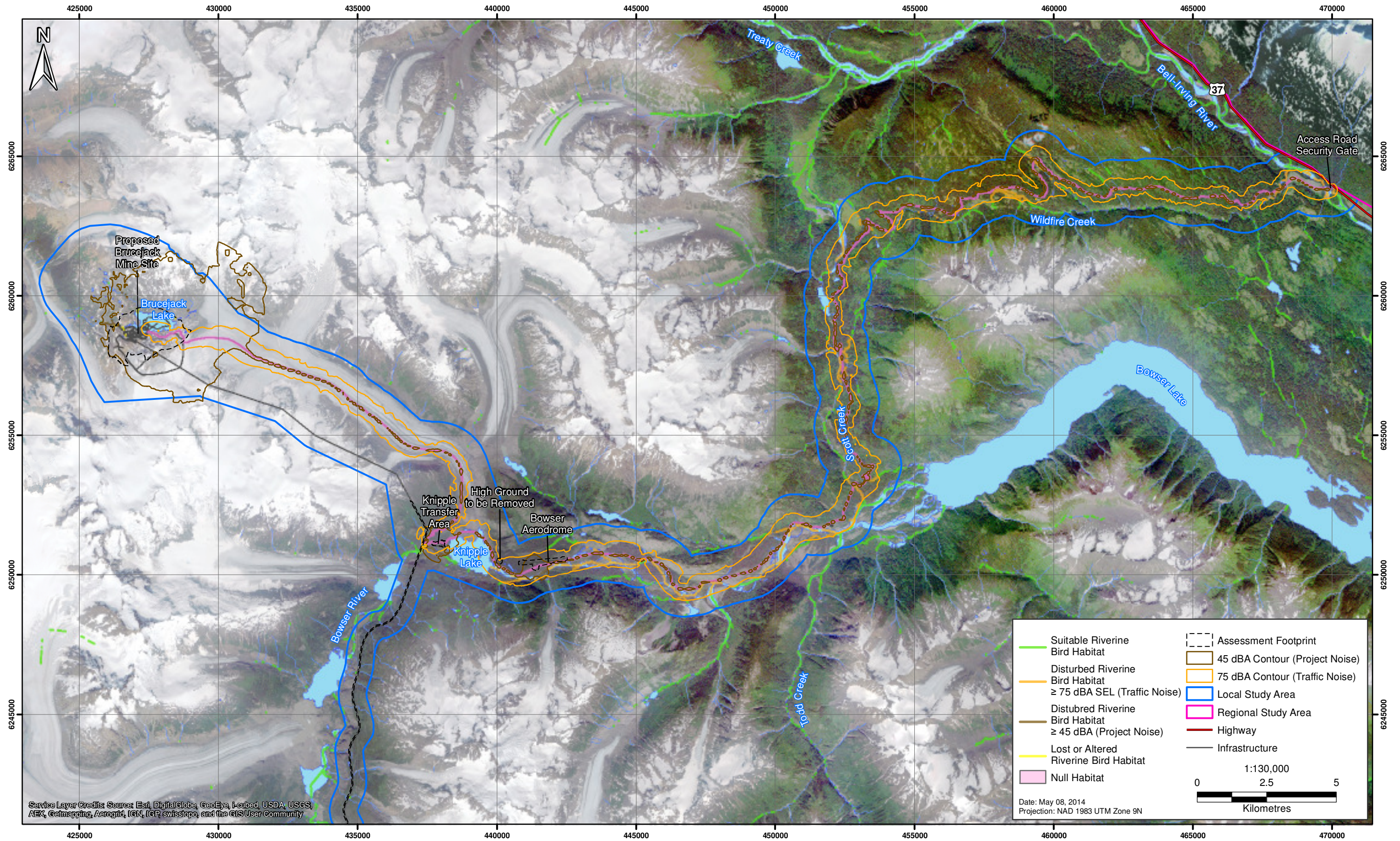
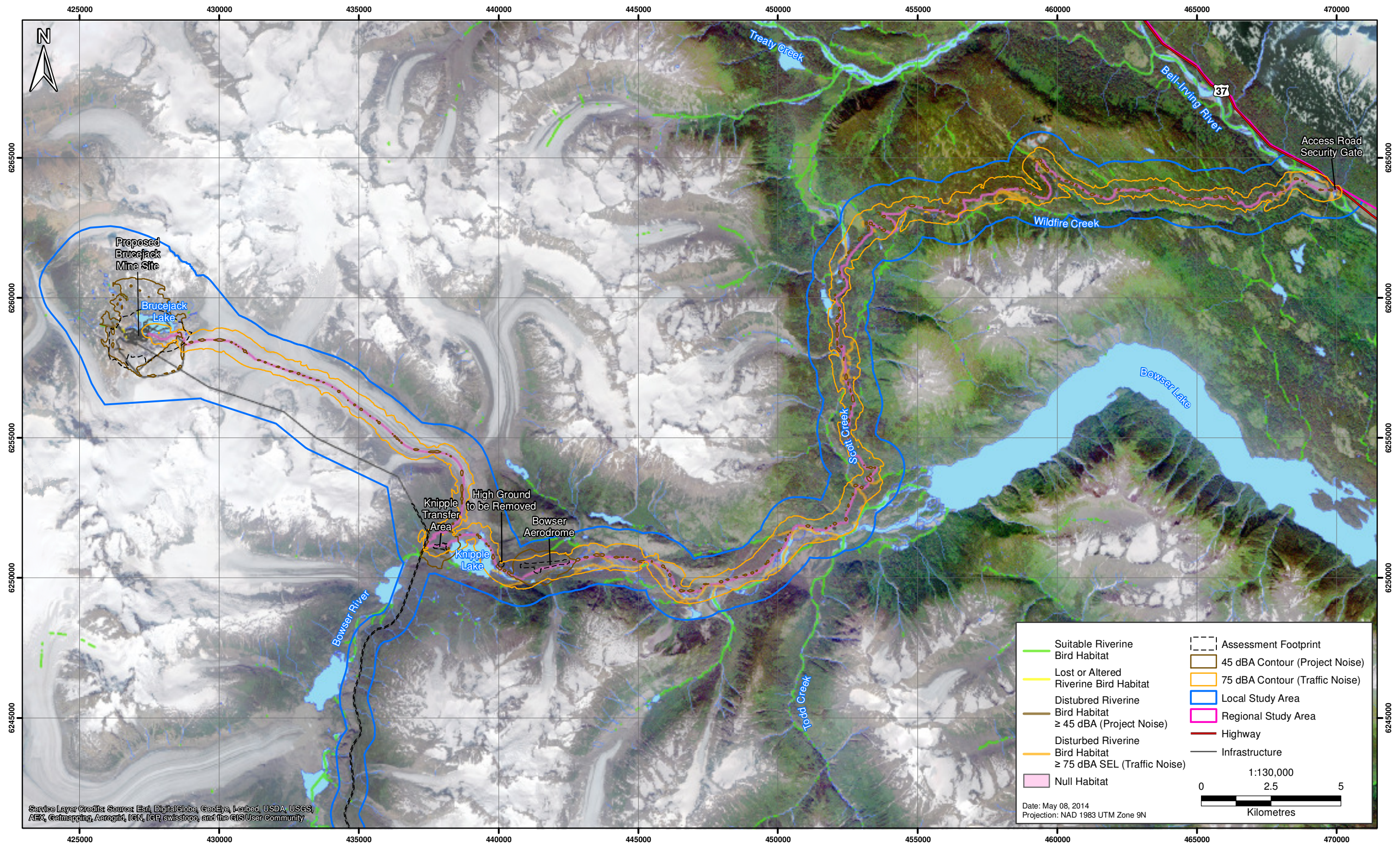
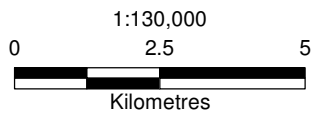


Figure 18.6-25b  
 Functional Loss of Suitable Habitat for Riverine Birds due to Noise – Operation



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Date: May 08, 2014  
 Projection: NAD 1983 UTM Zone 9N



### Residual Effects for Migratory Waterbirds due to Attractants

The effect of attractants is not anticipated to result in a residual effect on waterbirds. Monitoring of waterbird use of Brucejack Lake will be conducted; if species are attracted to the area and it is considered a potential hazard, measures will be taken to prevent waterbirds from using these areas. After mitigation, no residual effect on waterbirds is anticipated due to attractants.

### 18.6.9 Potential Residual Effects on Migratory Landbirds

#### 18.6.9.1 Identifying Key Effects

Migratory landbirds were assessed for potential Project-related effects. Habitat loss and alteration, sensory disturbance, direct mortality, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on landbirds. The effects of disruption of movement and indirect mortality were scoped out of this assessment because they were determined to have no interaction with landbirds. The potential residual effects considered in the assessment for landbirds are summarized in Table 18.6-15, and described in the following sections, from Section 18.6.9.2 to 18.6.9.6.

**Table 18.6-15. Ranking Potential Effects on Migratory Landbirds**

Project Components/ Physical Activities	Potential Effects on Migratory Landbirds						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	●	○	●	○
Access Road	○	○	○	●	○	○	○
Transmission Line	●	●	○	●	○	○	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	●	○	○	○	●	○
Access Road	●	○	○	●	○	○	○
Transmission Line	●	○	○	○	○	○	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	○	○	○	○	○	○
Access Road	●	○	○	●	○	○	○
Transmission Line	○	○	○	○	○	○	○

**Notes:**

○ = No interaction expected; no monitoring required, no further consideration warranted.

● = Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; if minor, may require monitoring; may warrant further consideration.

● = Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.

● = Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.

Disruption of movement is not considered a potential effect for landbirds as these species can avoid infrastructure by flying around or over obstacles. Tall structures with lights are known to attract migratory birds during their nocturnal migration. Birds can become exhausted while circling lights, and can collide with lit structures resulting in mortality events (T. Longcore et al. 2013). Examples of tall structures with lights include aviation towers. Although an aerodrome will be constructed, infrastructure at the aerodrome will be limited and will not include an aviation tower. No tall structures with lights will be constructed for the Project. Thus, disruption of movement is not considered to affect migratory landbirds.

Indirect mortality is not considered a potential effect for migratory landbirds because the primary source of indirect mortality identified for wildlife VCs in association with Project development is increased harvesting pressure, and landbirds are not hunted or trapped.

#### 18.6.9.2 *Habitat Loss and Alteration*

A total of 55 species of landbirds were identified during the 2010 and 2012 baseline studies ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report). These species occupy a diverse array of habitats, including intact forest stands, forest edges, alpine habitat above the treeline, and wetlands. Given the diversity of habitats occupied by this group, a qualitative assessment of habitat loss was performed. The majority of bird species comprising this group were observed within the CWHwm and ICHvc BEC zones, but species were also detected within the ESSFwv and MHmm2 BEC zones. Within the RSA, BAFAunp and CMAunp also occur and ptarmigan and other alpine species are likely to occur in these areas; therefore these BEC subzones are included in the analysis of habitat loss and alteration.

Four species of conservation concern were observed: barn swallow (BC blue-listed), olive-sided flycatcher (BC blue-listed; Schedule 1 as Threatened under the Species at Risk Act [2002c]), rusty blackbird (BC blue-listed; Schedule 1 as of Special Concern under the Species at Risk Act [2002c]), and sooty grouse (BC blue-listed). As active nests and eggs are protected under the *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) and *Migratory Birds Convention Act* (1994), effects of habitat loss and alteration are considered for this group, and mitigation is required to prevent the removal of active nests during Construction.

#### Landbird Habitat Requirements and Availability

Overall, landbirds occupied all of the BEC zones within the LSA and RSA in varying densities. The majority of landbird species were observed within the ESSFwv and ICHvc BEC zones, and on average, the high elevation CMAunp and BAFAunp BEC zones supported fewer breeding pairs and few species (Rescan 2013). Species were also detected within the MHmm2 BEC zone. Although the CWHwm BEC zone falls within the RSA boundary, no baseline studies were conducted in this zone as it does not occur in the LSA.

#### Landbirds Habitat Loss and Alteration

Direct habitat loss and alteration (i.e., Project assessment footprint) would occur wherever forest stands are cleared. Most songbirds are sensitive to habitat features such as vegetation composition and vertical stratification, snags, and the age of trees within a stand (Harrison, Schmiegelow, and Naidoo 2005). In addition to direct removal of forest stands, removal of snags and other debris from otherwise open areas can constitute habitat loss for species that rely on these features. As landbirds are ubiquitous throughout the study areas, habitat loss and alteration was calculated for all the BEC zones within the LSA (excluding 341 ha of previously disturbed habitat along the access road within the LSA) and RSA that overlapped with the individual Project components (Table 18.6-16).

**Table 18.6-16. Landbird Habitat Loss and Alteration due to the Project Infrastructure**

BEC Zone Habitat	Habitat Lost and Altered (ha)	LSA		RSA	
		Habitat Available (ha)	Habitat Lost/ Altered (%)	Habitat Available (ha)	Habitat Lost/ Altered (%)
ICHvc	0	4,196	0	43,445	0
ESSFwv	137.8	6,698	3.28	72,414	0.19
MHm2	6.4	173	0.04	29,423	0.02
BAFAunp	9.7	2,234	0.43	58,084	0.02
CMAunp	233.6	2,390	9.8	32,157	0.7
<b>Total</b>	<b>387.5</b>	<b>15,691</b>	<b>2.5</b>	<b>246,051</b>	<b>0.16</b>

Overall, at the end of the Operation phase, 388 ha (0.16% of the RSA, 2.5% of the LSA) of migratory landbird habitat will be removed or altered (Table 18.6-16). The majority of this loss and alteration will occur in the CMAunp BEC zone (234 ha) at high elevation near the Brucejack Mine Site, and the ESSFwv BEC zone (138 ha) along the Brucejack Transmission Line and Bowser Aerodrome.

The four species of conservation concern (barn swallow, olive-sided flycatcher, rusty blackbird, and sooty grouse) were observed in a variety of habitats and BEC zones. The rusty blackbird was observed incidentally within the ICHvc BEC zone, within which no habitat loss or alteration is expected (Table 18.6-16). The olive-sided flycatcher was observed in the ICHvc, ESSFwv, and MHm2 BEC zones. Again, no habitat loss or alteration is expected in the ICHvc BEC zone, while 144 ha of ESSFwv and MHm2 combined will be lost or altered. This represents less than 1% of the available suitable habitat in the RSA. Barn swallows were observed in the ICHvc BEC zone, which is not anticipated to experience any loss or alteration. Finally, one sooty grouse was observed during baseline surveys in CMAunp habitat along the proposed Brucejack Transmission Line ROW. Less than 1% of the available CMAunp habitat in the RSA will be lost or altered.

#### Residual Effects for Migratory Landbirds due to Habitat Loss and Alteration

Direct habitat loss and alteration is not predicted to result in a residual effect on landbirds, including SARA-listed species and provincial species of conservation concern. It is expected that birds will establish other territories and the disruption will be temporary.

Mitigation for this group will include timing windows for clearing. Pre-clearing surveys within seven days prior to vegetation clearing will be conducted if clearing is to take place during the breeding season (April 1 to July 31, but modified based on elevation and phenology). Buffer distances will be established and implemented around identified active nests and will be avoided during the breeding season until nestlings have fledged (Section 29.21, Wildlife Management and Monitoring Plan). Because the majority of the available forested habitat within the RSA will remain, with mitigation, no residual effect of habitat loss and alteration is predicted for migratory landbirds.

#### *18.6.9.3 Sensory Disturbance*

Sensory disturbance to landbirds can occur due to continuous noise from Construction and Operation phases of the Project (Reijnen and Foppen 1995; Fernandez-Juricic, Jimenez, and Lucas 2001; T. Longcore and Rich 2004). Habitat areas have the potential to be functionally lost if elevated noise levels prevent effective auditory communication. A study of grassland bird density along roads reported that the overall bird density was lower in areas above the threshold value of 47 dBA (Reijnen, Foppen, and Meeuwse 1996).

A GIS analysis was conducted to determine the areas where sensory disturbance may be the most prevalent during Construction and Operation using a threshold of 45 dBA. The total area of suitable habitat identified in Section 18.6.7.2 was used for the analysis. The area of habitat that falls outside of the area of direct habitat lost due to the footprint, but within the noise level contours thresholds or greater, was calculated.

The total area of suitable landbird habitat within the RSA that may be disturbed due to continuous Project noise is 881 ha (0.36% of the RSA, 4.9% of the LSA) during Construction and 523 ha (0.21% of the RSA, 3.3% of the LSA) during Operation. The majority of Construction disturbance will be associated with the Brucejack Mine Site (495 ha) and along the access road from the highway to the Bowser Aerodrome (153 ha). The majority of Operation disturbance will be associated with the Knipple Transfer Area, Bowser Aerodrome (245 ha), and the Brucejack Mine Site (188 ha).

#### Residual Effects for Migratory Landbirds due to Sensory Disturbance

Sensory disturbance is not predicted to result in a residual effect on migratory landbirds. Less than 1% of the available habitat in the RSA may be disturbed due to Project noise. Due to the small amount of habitat and with mitigation (e.g., pre-clearing surveys), no residual effect of sensory disturbance is predicted for landbirds.

#### *18.6.9.4 Direct Mortality*

The potential sources of migratory landbird mortality in association with the Project will be mortality resulting from collisions with vehicles and the destruction of active nest sites during Construction.

##### *Vehicle Collisions*

Direct mortality of landbirds, particularly flocking species such as pine siskins and crossbills, may occur because of traffic along the access road. Most road mortalities to these species occur during winter or early spring (Campbell, Dawe, McTaggart-Cowan, Cooper, Kaiser, McNall, et al. 1997). Carduelinae finches (i.e., crossbills, grosbeaks, and siskins) are particularly vulnerable to vehicle collisions on highways, as they are attracted to road salts, gravel, and sand (Mineau and Brownlee 2005).

##### *Vegetation Clearing*

Construction activities could result in direct mortality of landbirds through clearing of vegetation actively used for nesting. The habitat selected by nesting birds is described in Section 18.6.9.2, as well as a quantitative analysis of the amount that will be cleared. The *Wildlife Act* (Pahlke, McPherson, and Marshall 1996) specifically protects birds, their nests, and their eggs from possession, molestation, or destruction. Therefore, mitigation measures will be implemented, including timing of vegetation clearing and pre-construction surveys as required.

#### Residual Effects for Migratory Landbirds due to Direct Mortality

The effect of direct mortality is not anticipated to result in a residual effect on landbirds. The mitigation proposed to limit the effects of habitat loss (Section 18.6.9.2) for landbirds will assist in mitigating the potential for direct mortality effects. Pre-clearing surveys for active nests would be conducted before clearing if development activities take place during the breeding season (April 1 to July 31; Section 18.6.9.2).

Speed restrictions can be imposed to reduce incidences of vehicle-wildlife collisions. Direct mortality rates of wildlife species have been shown to drop dramatically below 70 km/hour (Seiler 2005; Ng, Nielson, and St Clair 2008). The maximum speed limit on access road will be 40 km/hour, which will result in substantially reduced mortality to landbirds, compared to what would be expected along

typical highways. During the winter months, mortality of Carduelinae finches is a concern. Mitigation on the access road may include the monitoring of winter flocking bird (e.g., finch) mortality and timing of application of de-icing sand (no salt added) to reduce excessive use (Jacobson 2005). Overall, no residual effect of direct mortality on migratory landbirds is anticipated.

#### 18.6.9.5 *Attractants*

A small portion of the upland bird community may be attracted to the areas close to the Project footprints or to Project infrastructure for establishment of breeding territories. It is possible that birds may use Project infrastructure as habitat (e.g., elevated sites for perching, singing, and nesting). Barn swallow displayed nesting behaviour at Pretium Resources Inc. (Pretium) exploration camps and a nest was recorded at the site of the proposed Brucejack Transmission Line (Rescan 2013).

#### Residual Effects for Migratory Landbirds due to Attractants

The effect of attractants on migratory landbirds is not anticipated to result in a residual effect. This effect will be minimized by mitigation measures to limit access to infrastructure by birds and to remove nesting material prior to egg-laying. With the application of mitigation activities, no residual effect on upland birds is predicted to occur as a result of their attraction to Project infrastructure and activities.

### 18.6.10 **Potential Residual Effects on Western Toads**

#### 18.6.10.1 *Identifying Key Effects*

Western toads were assessed for potential Project related effects. Habitat loss and alteration, direct mortality, disruption of movement, attractants, and chemical hazards were considered for the effects assessment because those effects have the potential to create a residual effect on western toads. The effect of sensory disturbance and indirect mortality were scoped out of this assessment because they are effects determined to have no interaction with western toads. The potential residual effects considered in the assessment for western toads are summarized in Table 18.6-17, and described in the following sections, from Section 18.6.10.2 to 18.6.10.7.

Sensory disturbance is not considered a potential effect on western toads because the population within Northwest BC is considered a subpopulation of western toads known as the non-calling population (COSEWIC 2012a) which are not sensitive to increased noise levels. Therefore, the effect of sensory disturbance on western toads was not assessed.

#### 18.6.10.2 *Habitat Loss and Alteration*

The assessment of habitat loss due to the Project focuses on suitable breeding habitat for western toads (excluding 341 ha of previously disturbed habitat along the access road within the LSA). This species is sensitive to habitat fragmentation resulting from resource extraction and road networks (COSEWIC 2012a). The western toad is provincially blue-listed, and is protected under the BC *Wildlife Act* (Pahlke, McPherson, and Marshall 1996), which states that western toads cannot be killed, collected, or held in captivity without a permit. Federally, it has been designated a species of Special Concern by COSEWIC (COSEWIC 2002a), and is listed on Schedule 1 of SARA (BC CDC 2013), which requires monitoring under section 79(2) (SARA 2012). Internationally, the western toad is red-listed as endangered by the International Union for Conservation of Nature for being at high risk of extinction in the wild (Wind and Dupuis 2002). It is the only international red-listed amphibian in Canada (Government of Canada, 2013).

**Table 18.6-17. Ranking Potential Effects on Western Toads**

Project Components/ Physical Activities	Potential Effects on Western Toads						
	Habitat Loss and Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
<b>Construction</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	○	●	●	○	●	○
Access Road	●	○	●	●	○	●	○
Transmission Line	●	○	●	○	○	○	○
<b>Operation</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	●	○	●	●	○	●	○
Access Road	●	○	●	●	○	●	○
Transmission Line	●	○	●	○	○	○	○
<b>Closure and Post-closure</b>							
Mine Site/Knipple Transfer Area/ Browser Aerodrome	○	○	●	●	○	●	○
Access Road	○	○	●	●	○	●	○
Transmission Line	○	○	○	○	○	○	○

**Notes:**

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

To evaluate the potential effects of the proposed Project on western toad habitat the BEC system was used to identify suitable breeding habitat. Within the LSA, a detailed wetland classification was implemented using western toad observation data and wetland classes (Chapter 17, Assessment of Potential Wetland Effects). Wetlands with records of western toad observations from baseline studies were ranked high. Moderate ranking wetlands were identified as potential western toad habitat based on a review of all wetlands with a component of shallow open water using the Purview GIS application. High- and moderate-ranking wetlands were considered suitable western toad breeding habitat. Within the RSA, wetlands identified by Terrestrial Resource Inventory Mapping were used to classify potential wetland habitat for western toads. As these wetlands were not reclassified using Purview to identify shallow open water most suitable for western toad breeding, this number is likely an overestimate of available suitable habitat.

Habitat alteration and degradation may occur as a result of wetland function degradation due to additional road upgrade activities (e.g., sedimentation, dust; Chapter 17, Assessment of Potential Wetland Effects). Degradation of wetland function has been identified based on the proximity of wetlands to road activity upgrades along the Brucejack Access Road. The sources of potential degradation of wetland function by the Project include changes in wetland hydrological functions due

to changes in surface and groundwater flow due to the access road upgrade activities. Dust inputs from the Brucejack Access Road could alter biochemical and habitat functions by changing pH and nutrient concentrations. Sedimentation and contaminants from the access road could affect habitat, biochemical processes, and hydrological functions by changing physical properties related to water storage and treatment. Furthermore, the introduction of invasive species can alter all wetland functions by changing abiotic and biotic processes.

#### Western Toad Habitat Requirements and Availability

Western toads require a variety of terrestrial and aquatic habitats to complete the different stages of their life cycle (Section 18.3.6.1). Toads migrate over relatively long distances each spring (i.e., May through June) from their winter hibernation sites to aquatic breeding sites. Spring breeding requires aquatic sites such as ponds, lakes, quiet stream sides, and other wetland areas with shallow open water, an open tree canopy, and warm water. Eggs develop into tadpoles in ponds and toadlets emerge in late July or August and disperse into surrounding terrestrial areas to summer foraging and winter hibernation habitat.

Suitable breeding habitat was defined as moderate (i.e., potential presence of western toad) and high (i.e., if western toads were detected during baseline studies). A total of 286 ha of suitable breeding habitat was identified in the LSA (Figures 18.6-26a, 18.6-26b, 18.6-26c). Within the RSA a total of 832 ha of potential western toad breeding habitat was identified using the Terrestrial Resource Inventory Mapping wetlands classification.

The wetland risk-based approach analysis (Chapter 17, Assessment of Potential Wetland Effects) identified approximately 96 ha of wetlands that will be at high/moderate risk of degradation adjacent or near the Brucejack Access Road, 72 ha of which represents western toad breeding habitat. Overall, 72 ha (25%) of the 286 ha of suitable western toad breeding habitat within the LSA are at high/moderate risk of degradation, potentially causing habitat alteration (Figure 18.6-26d).

#### Western Toad Habitat Loss and Alteration

No suitable western toad breeding wetland habitat will be lost (i.e., Project assessment footprint) due to Project infrastructure (Figures 18.6-26a, 18.6-26b, and 18.6-26c). Due to the additional road upgrades adjacent to suitable habitat, there may be some habitat alterations to western toad breeding wetland habitat (Figure 18.6-26d).

#### Residual Effects for Western Toads due to Habitat Loss and Alteration

As there will be no suitable western toad breeding wetland habitat lost in the LSA or RSA, no residual effects are anticipated.

Habitat alteration and wetland degradation could result in a residual effect for western toads. Potential degradation may occur due to sedimentation and runoff, hydrological connectivity, fragmentation, edge effects, dust, water quality, and invasive species. Mitigation measures include special management practices in riparian areas surrounding wetlands. Mitigation includes the implementation of a Wetlands Monitoring Plan (Section 29.20) proposed to verify the residual effects on wetland function associated with the Project. The Wetlands Monitoring Plan (Section 29.20) was designed to collect information on the primary functions of wetlands at three sites. With mitigation, no residual effect is anticipated for western toad due to the risk of degradation of wetlands adjacent to roads.

### 18.6.10.3 *Disruption of Movement*

Western toads use terrestrial habitats for most of the year (Bartelt and Peterson 1994) but return to aquatic habitats to breed. Toads migrate over relatively long distances each spring (May to June) from their winter hibernation sites to aquatic breeding sites, and then to forested foraging areas during the summer. Eggs develop to tadpoles and toadlets in ponds and toadlets emerge in late July or August and disperse into surrounding terrestrial areas. Toads are capable of moving over 5 km to breeding sites (T. M. Davis 2002). Females typically move farther away from breeding sites because they tend to breed once every two years, while males remain closer to breeding sites as they breed annually (Muths 2003).

Several wetlands close to the access road were identified as suitable breeding habitat for toads (Figures 18.6-26a, 18.6-26b, and 18.6-26c). The access road and infrastructure located near wetlands suitable for western toads could potentially create barriers for toad movements through direct mortality (vehicle-toad collisions). Toads are terrestrial animals and prefer open, sunny areas to dense forests. Hence, toads are at risk of vehicle–toad collisions when sunning themselves on roads, crossing roads to access breeding ponds, or during mass migrations of toadlets from breeding ponds to terrestrial summer and winter habitat (Section 18.6.10.5).

#### Residual Effects for Western Toads due to Disruption of Movement

The effect of disruption of movement on western toads is not anticipated to result in a residual effect. Monitoring is proposed in the LSA to identify locations along the access road where there is a high probability of bisecting toad movement corridors between terrestrial and aquatic habitats. Where corridors are identified, access road construction will incorporate provisions such as specialized toad tunnels or amphibian culverts under the road to facilitate movement (Section 29.21, Wildlife Management and Monitoring Plan). Monitoring for western toad mortality along the road will also form a component of the Wildlife Management and Monitoring Plan (Section 29.21). After mitigation, no residual effect on western toad movement is anticipated.

### 18.6.10.4 *Direct Mortality*

The potential sources of western toad direct mortality in association with the Project will be mortality resulting from collisions with vehicles and due to heavy machinery use in western toad terrestrial and aquatic habitat during the Construction phase.

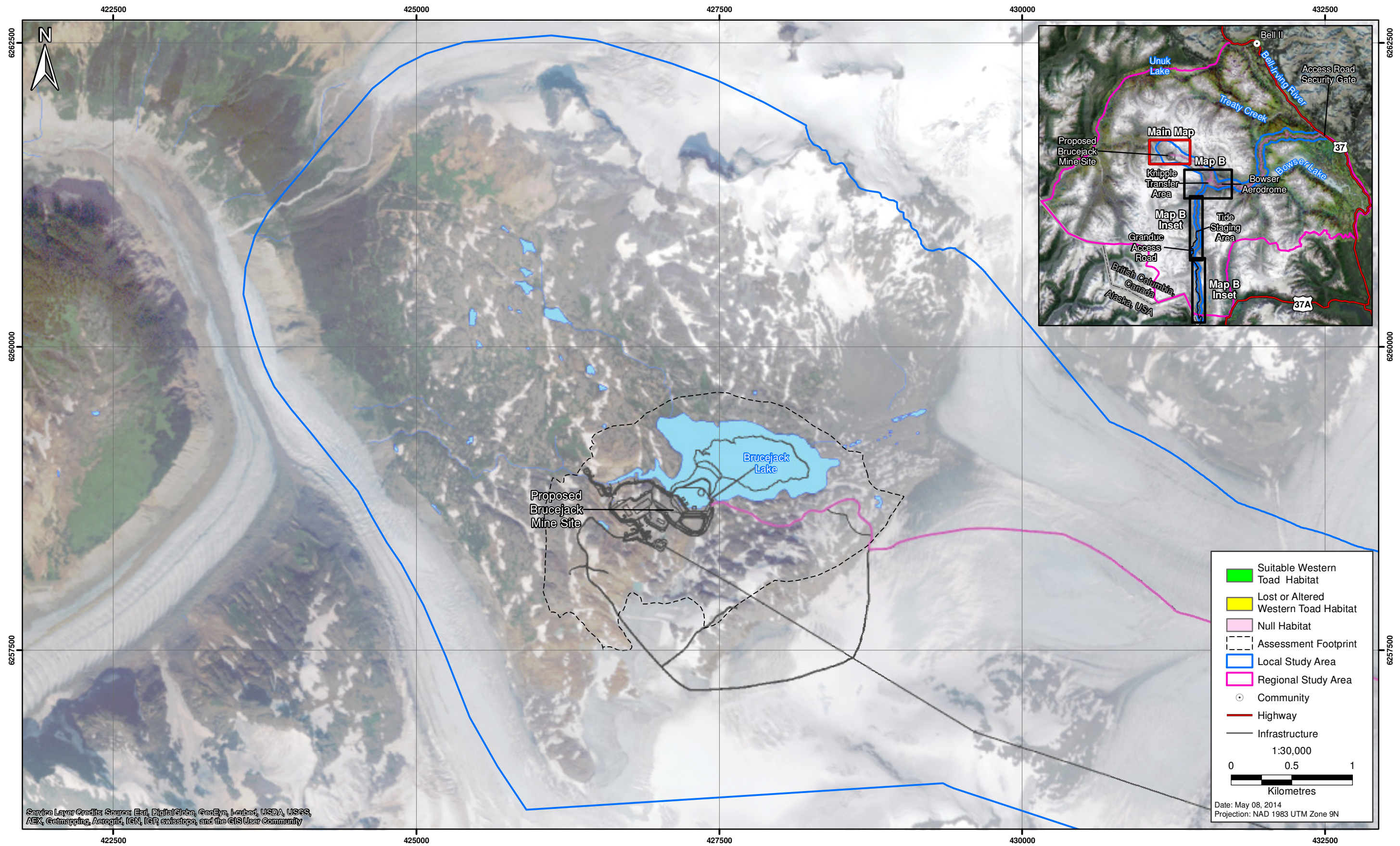
#### Vegetation Clearing

Direct mortality could occur due to impacts from heavy machinery involved in Project-related construction or vehicles moving through the area. Toads utilize a variety of terrestrial habitats including all forest and woodland types. If Construction is occurring during the breeding season, it may also affect toad breeding ponds due to sedimentation. Additional road upgrades along the Brucejack Access Road may impact wetlands and western toad breeding habitat (see Habitat Loss and Alteration, Section 18.6.10.2 and Figure 18.6-26d).

#### Vehicle Collisions

The greatest concern for western toad populations during Construction and Operation will be direct mortality and injury of adults and newly emerged terrestrial juveniles near roads and close to wetlands during the spring and late summer. Both high- and low-traffic roads can cause mortality, particularly during breeding migrations to and from breeding ponds from upland terrestrial habitat (Lesbarrères, Lodé, and Merilä 2004). Western toads will disperse more than 600 m from breeding sites (Rittenhouse and Semlitsch 2007). Suitable toad breeding habitat was identified along the access road; therefore, there is potential for toads and toadlets to be moving from breeding sites to upland areas.

Figure 18.6-26a  
Western Toad Wetland Habitat Lost or Altered due to the Project



Source Layer Credits: Source: Esri, DigitalGlobe, GeoEye, IGN, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 18.6-26b  
Western Toad Wetland Habitat Lost or Altered due to the Project

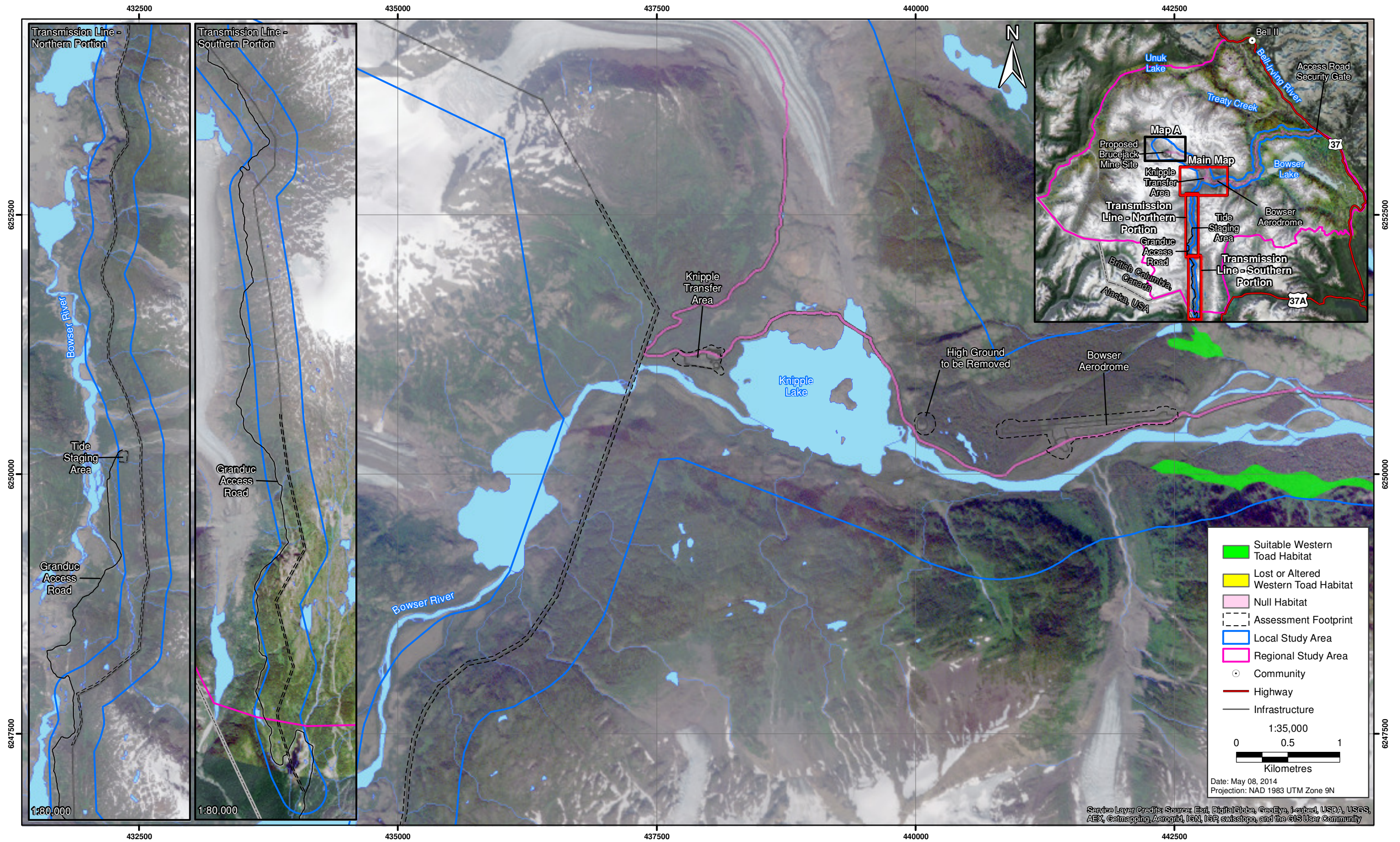


Figure 18.6-26c  
 Western Toad Wetland Habitat Lost or Altered due to the Project

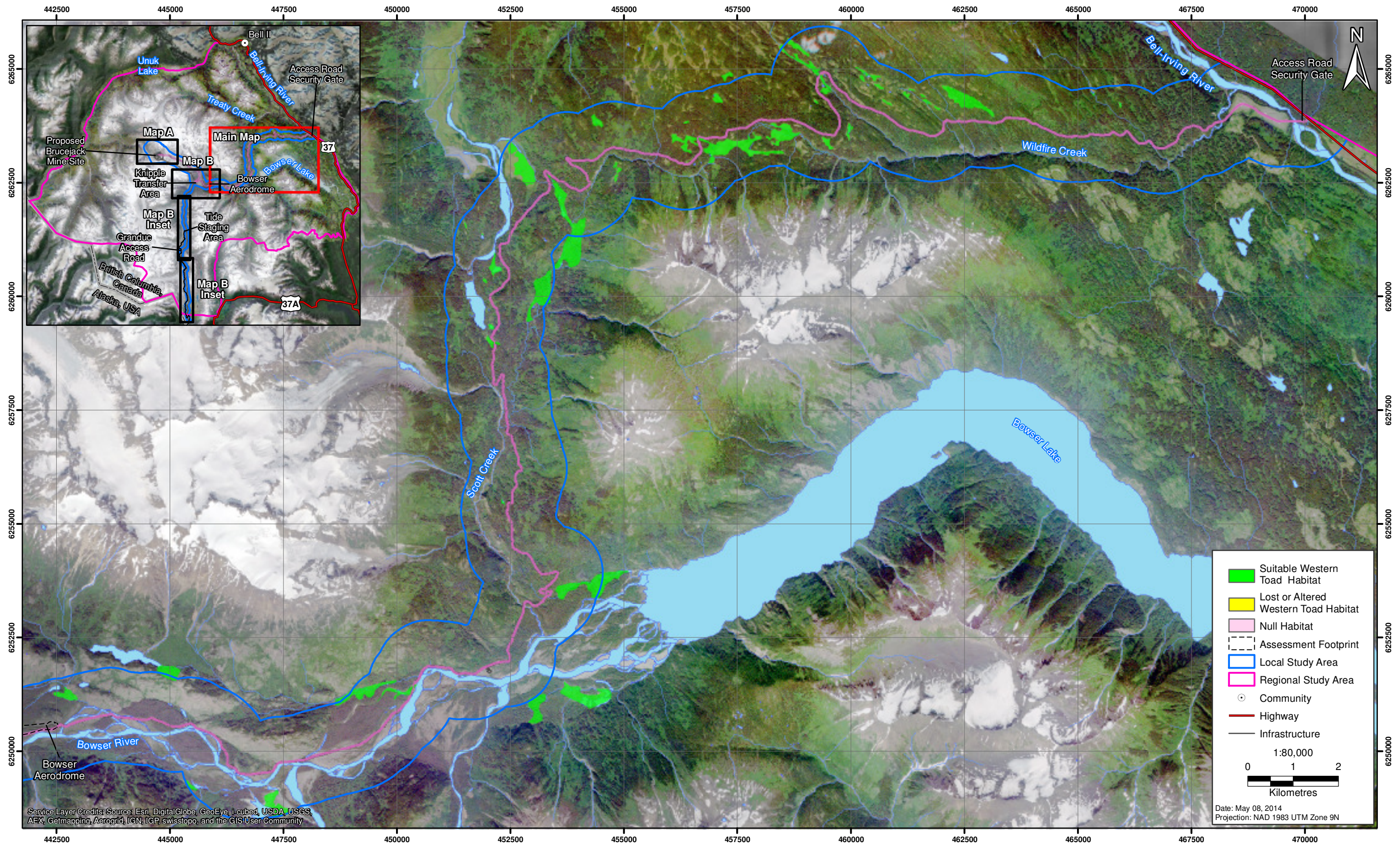
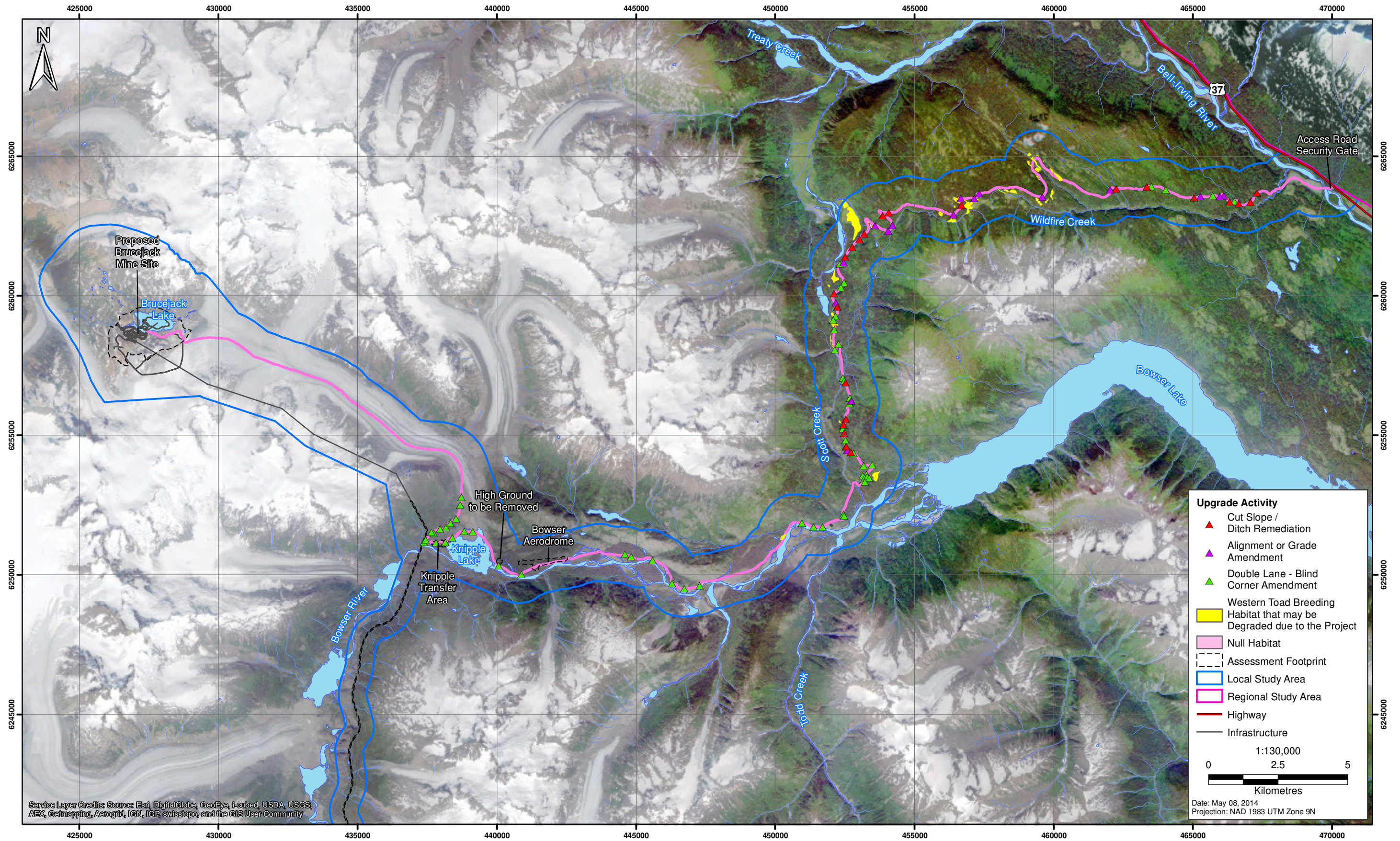


Figure 18.6-26d  
Western Toad Breeding Habitat that may be Degraded due to the Project



### Residual Effects for Western Toads due to Direct Mortality

The effect of vegetation clearing is not predicted to result in a residual effect on western toads due to additional upgrades to the Brucejack Access Road. Mitigation measures include special management practices in riparian areas surrounding wetlands, such as hand felling of trees, siltation control when working in riparian areas, and avoiding alteration of wetland conditions by limiting machinery use in these areas. Pre-clearing surveys will be conducted on any ponds that are identified as being affected by construction during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad breeding ponds. Use of machinery and associated Construction phase activities (i.e., tree felling) would be avoided in identified breeding ponds during those periods. Mitigation measures for non-riparian areas can include on-the-ground surveys prior to vegetation removal that can be carried out in concert with migratory landbird surveys.

The effect of direct mortality is predicted to result in a residual effect on western toads, primarily due to vehicle mortality impacts.

Due to the high concentration of wetlands adjacent to the access road, it is anticipated that toads may use and/or cross the roads travelling between wetlands. To mitigate potential direct mortality effects, toad dispersal and vehicle impact mortality will be monitored, and mitigation measures such as toad tunnels and culverts may be installed. Despite mitigation, residual effects due to direct mortality are anticipated for western toads because of the proximity of the access road to western toad breeding sites.

#### *18.6.10.5 Attractants*

Western toads utilize a variety of natural wetland areas for breeding, as well as man-made structures such as ditches and road ruts (Gyug 1996; COSEWIC 2002a). These pools often have similar site characteristics to natural breeding ponds, including open forest canopy, warm water temperature, shallow water, and a gentle-sloped muddy bank. The use of these types of temporary pools by toads is of concern for two reasons. Firstly, the water in roadside ditches or ruts may dry up before toads complete metamorphosing between tadpole and toadlet, which would result in complete mortality of tadpoles. Secondly, if the water does persist for long enough, emerging toadlets are in the vicinity of Project roads and are thus at risk of mortality from vehicle traffic.

### Residual Effects for Western Toads due to Attractants

The effect of attractants on western toads is not anticipated to result in a residual effect. To avoid the creation of attractive roadside pools, the Project will construct drainage ditches that will promote free drainage. After mitigation, no residual effects on western toad are expected.

## **18.7 CHARACTERIZING RESIDUAL EFFECTS, SIGNIFICANCE, LIKELIHOOD, AND CONFIDENCE ON WILDLIFE**

Of the 10 wildlife VCs (moose, mountain goats, grizzly bears, American martens, hoary marmots, bats, raptors, migratory waterbirds, migratory landbirds, and western toads), five VCs (moose, mountain goats, grizzly bears, American marten, and western toads) may experience residual effects after mitigation, as described in the following sections.

Cumulative effects of the Project and additional surrounding industrial projects, forestry and other land use activities are presented in Section 18.9.

The following sections (18.7.1 to 18.7.5) assess the potential Project-related effects and significance on each VC experiencing residual effects. The assessment considered results of wildlife baseline studies ([Appendices 18-A](#) and [18-B](#)), regional planning documents, and scientific literature. The duration and frequency of each potential effect was considered when determining the potential effects of greatest

concern. For example, an effect that occurs continuously beyond the life of the Project is likely to be of greater concern than a short-term effect that is confined to a discrete time period (Table 18.7-1). Each section is subdivided according to the issues deemed to be of concern for that VC. Within each section, the extent and significance of adverse potential effects of the Project on wildlife VCs are predicted and discussed. A detailed description of the effects assessment methodology, logic, variables, and descriptors are to be found in Chapter 6, Assessment Methodology.

In some cases, population-level effects could result from the combined effects of habitat loss, disruption of movement, sensory disturbance, mortality (direct and indirect), attractants, and/or chemical hazards, even when each of these effects are independently not rated as potentially significant residual effects. Multiple effects may combine to produce a greater effect, as one effect may weaken the resilience of a VC to a subsequent or concurrent effect. This predicted “overall significance” of potential effects on each VC is assessed within each section for each VC that may experience two or more residual effects.

The likelihood (probability) of the residual effect occurring is made prior to a significance determination. Once significance is determined, the confidence in the significance predictions is stated.

### 18.7.1 Residual Effects Assessment for Moose

Residual effects are those effects predicted to remain after the application of the Wildlife Management and Monitoring Plan (Section 29.21). Three potential effects (as predicted in Section 18.6.1) are predicted to have residual effects on moose after mitigation: disruption to movement, direct mortality, and indirect mortality (Table 18.7-2).

#### 18.7.1.1 Residual Effects of Disruption of Movement on Moose

##### Residual Effect Characterization

The distribution of infrastructure along the Bowser River, the presence of the access road, and traffic along the access road may impede movement of moose between valley systems, beginning during the Construction phase. After mitigation, the residual effect of disruption of moose movements is expected to have a low magnitude. The extent of this effect will be at the landscape scale because movement may be disruptive to individuals within the watershed. The duration will be long term because infrastructure will be either fully or partially reclaimed and traffic volumes will cease in the Post-closure phase when the road has been reclaimed. The frequency will be sporadic, as the moose movement will likely only be disrupted when moose are travelling through the Project footprint. The effect will be reversible long term because of reclamation. The context of the moose population is high, as the moose population in the RSA is considered to have low resilience to imposed stresses.

##### Likelihood of Residual Effect

The probability of disruption of movement occurring is medium, as moose are likely to be disrupted; however, the effect may not occur.

##### Significance of Residual Effect

The effect of disruption of moose movement is assessed as **not significant**.

##### Characterization of Confidence

Confidence of this analysis is medium because it has been assumed that these valleys are movement corridors, but no movement data have been gathered in the field. The Skii km Lax Ha that reported they have harvested moose within the Bowser River valley.

**Table 18.7-1. Significance Determination Criteria of Residual Effects for Wildlife**

Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Context	Likelihood	Significance	Confidence Level
<p><b>Low:</b> The magnitude of effect differs from the average value for baseline conditions, but is within the range of natural variation of the local population and well below a guideline or threshold value (if it exists).</p>	<p><b>Short-term:</b> The effect lasts approximately 1 to 5 years.</p>	<p><b>Once:</b> The effect occurs once during any phase of the project.</p>	<p><b>Local:</b> The effect is limited to the immediate Project footprint (e.g. within a 100 m buffer) and/or to individuals within the buffer.</p>	<p><b>Reversible Short-term:</b> An effect that can be reversed relatively quickly (e.g., within a few days or less).</p>	<p><b>Low:</b> The receptor VC is considered to have little to no unique attributes and/or there is high natural resilience to impose stresses, and can respond and adapt to the effect.</p>	<p><b>Low:</b> This effect is unlikely but could occur.</p>	<p><b>Not significant:</b> Residual effects may have low or moderate magnitude, local to regional geographic extent, short- or medium-term duration, could occur at any frequency, and are reversible in either the short or long term. The effects on the receptor VC (e.g., at a species or local population level) are either indistinguishable from background conditions (i.e., occur within the range of natural variation as influenced by physical, chemical, and biological processes), or distinguishable at the individual level. Land and resource management plan objectives will likely be met, but some management objectives may be impaired. There is a medium to high level of confidence in the analyses. Follow up monitoring of these effects may be required if the magnitude is medium.</p>	<p><b>Low:</b> &lt; 50 % confidence. The cause-effect relationship(s) between the Project and its interaction with the environment is poorly understood and/or data for the Project area or scientific analyses are incomplete, leading to a high degree of uncertainty.</p>
<p><b>Moderate:</b> The magnitude of effect differs from the average value for baseline conditions and approaches the limits of natural variation of the local population, but below or equal to a guideline or threshold value.</p>	<p><b>Medium-term:</b> The effect lasts from 6 to 25 years.</p>	<p><b>Sporadic:</b> The effect occurs at sporadic or intermittent intervals during any phase of the project.</p>	<p><b>Landscape:</b> The effect extends beyond the project footprint to a broader watershed area, but remains tied to the footprint and/or to individuals within that watershed.</p>	<p><b>Reversible Long-term:</b> An effect that can be reversed over many years.</p>	<p><b>Neutral:</b> The receptor VC is considered to have some unique attributes, and/or there is neutral resilience to imposed stresses and may be able to respond and adapt to the effect.</p>	<p><b>Medium:</b> This effect is likely, but may not occur.</p>	<p><b>Significant:</b> Residual effects may have high magnitude; have regional or beyond regional geographic extent; duration is long-term or far future; and occur at all frequencies. Residual effects on receptor VCs are consequential (i.e., structural and functional changes in populations, communities, and ecosystems are predicted) and are irreversible. The ability to meet land and resource management plan objectives is impaired. Confidence in the conclusions can be high, medium, or low.</p>	<p><b>Medium:</b> 50 to 80 % confidence. The cause-effect relationship(s) between the Project and its interaction with the environment is not fully understood, and/or data for the Project area or scientific analyses are incomplete, leading to a moderate degree of uncertainty.</p>
<p><b>High:</b> The magnitude of effect is predicted to differ from baseline conditions and exceed guideline or threshold values so that there will be a detectable change beyond the range of natural variation of the local population.</p>	<p><b>Long-term:</b> The effect lasts between 26 and 50 years.</p> <p><b>Far Future:</b> The effect lasts more than 50 years.</p>	<p><b>Regular:</b> The effect occurs on a regular basis during any phase of the project.</p> <p><b>Continuous:</b> An effect occurs constantly during any phase of the project.</p>	<p><b>Regional:</b> The effect extends across the Regional Study Area and/or the population.</p> <p><b>Beyond regional:</b> The effect extends possibly across or beyond the province and/or the population.</p>	<p><b>Irreversible:</b> The effect cannot be reversed (i.e., is permanent).</p>	<p><b>High:</b> The receptor VC is considered to be unique and/or there is low resilience to imposed stresses, and will not easily adapt to the effect. This may be due to past human activity or ecological/social fragility, or a high level of existing stressors as baseline.</p>	<p><b>High:</b> It is highly likely that this effect will occur.</p>	<p><b>High:</b> &gt; 80 % confidence. The cause-effect relationship(s) between the Project and its interaction with the environment is well understood, and/or data for the Project area or scientific analyses are complete, leading to a low degree of uncertainty.</p>	

**Table 18.7-2. Summary of Residual Effects on Moose**

Residual Effects	Evaluation Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Geographic Extent (local, landscape, regional, beyond regional)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Ecological Context (low, neutral, high)			
Disruption of Movement	Low	Landscape	Long-term	Sporadic	Reversible long-term	Low	High	Medium	Not significant	Medium
Direct Mortality	Low	Landscape	Long-term	Sporadic	Reversible long-term	Low	High	Medium	Not significant	Medium
Indirect Mortality	Low	Landscape	Long-term	Sporadic	Reversible long-term	Low	High	Low	Not significant	Medium
Overall Effects	Moderate	Landscape	Far future	Sporadic	Reversible long-term	Low	High	Low	Not significant	Medium

### 18.7.1.2 *Residual Effects of Direct Mortality on Moose*

#### Residual Effect Characterization

Direct mortality due to vehicle collisions is assessed as a residual effect for moose because of traffic during the Construction and Operation phases of the Project. With mitigation and monitoring, the residual effects of direct mortality on moose will have a low magnitude (estimate of 1.3 vehicle-moose collisions per year along the access road), as it will likely remain within the natural variation of the local population. The extent of this effect will be landscape because it will remain tied to the Project. The duration will be long term because traffic will continue through the life of the mine, but will cease when the road is reclaimed. The frequency will be sporadic. The effect will be reversible long term because the risk of collision will decline when traffic volumes decline at closure. Because of the status of the moose population in the area (i.e., declining in the NWA and Highway 37 corridor) and the high-value habitat along the low elevation portions of the access road, the context of the population is high (and resiliency low).

#### Likelihood of Residual Effect

The probability of direct mortality occurring is medium (i.e., direct mortality is likely to occur, but it may not occur).

#### Significance of Residual Effect

Direct mortality is not expected to affect the viability of the local moose population (magnitude low), and thus this effect is considered to be **not significant**.

#### Characterization of Confidence

Confidence in this assessment is medium (50 to 80% confidence) because there is high confidence that a collision is likely to occur and low confidence in the predicted number of annual collisions (due to the low confidence in the WARS data).

### 18.7.1.3 *Residual Effects of Indirect Mortality on Moose*

#### Residual Effect Characterization

The Project roads were evaluated for the potential to increase hunting pressure as a result of increased access. The Brucejack Access Road will be gated and controlled for the life of the Project and will be reclaimed during the Post-closure phase, limiting unauthorized entry. Increased access may not be completely avoided or mitigated, thus a potential adverse residual effect of low magnitude is predicted for moose. The extent of this effect will be landscape because it remains tied to the Brucejack Access Road. The duration will be long term because the area may be accessible to some degree during Post-closure. The frequency will be sporadic. The effect will be reversible long term with planned road closure and adaptive mitigation. Because of the status of the moose population in the NWA and Highway 37 corridor (i.e., declining) and the high-value habitat along the access road, the context of the population is high.

#### Likelihood of Residual Effect

The probability of increased hunting is low given the mitigation planned (i.e., it is unlikely but could occur).

#### Significance of Residual Effect

The effect of indirect mortality on moose was assessed as **not significant**.

### Characterization of Confidence

The assessment is of medium confidence because the actual number of hunters who could use these areas and the associated effect on the local moose population is uncertain.

#### *18.7.1.4 Residual Overall Effects on Moose*

### Residual Overall Effect Characterization

Project-related residual effects (disruption of movement, direct mortality, and indirect mortality) were predicted for moose. These effects were individually rated as not significant. These effects may interact, and are evaluated for the potential to create additive or synergistic effects that have a different magnitude or extent for the local moose population within the RSA.

The three residual effects were predicted to have a low-magnitude effect. Several of the effects ratings also have medium certainty (e.g., efficacy of road closures to exclude hunters). Because of the low certainty, a cautionary approach should be taken to predict the outcome of these effects on moose and a rating of medium magnitude is predicted for the moose population within the RSA. The extent will be landscape and the duration will be long term (i.e., continue during Post-closure). The frequency will be sporadic. The effect will be reversible long term because the level of effects will decline at Closure. Because of the status of the moose population in the nearby NWA and Highway 37 corridor area (i.e., declining) and the high-value habitat within low elevation valleys in the LSA, the context of the population is high (and resilience low).

### Likelihood for Residual Effects

The probability of an overall residual effect is medium, as it is likely but may not occur.

### Significance of Overall Residual Effects

The overall residual effect of disruption of movement, direct mortality, and indirect mortality acting synergistically on moose is assessed as **not significant**.

### Characterization of Confidence

The assessment of the overall residual effects is of medium confidence because there is a low degree of confidence in most of the residual effects for moose.

## **18.7.2 Residual Effects Assessment for Mountain Goats**

Residual effects are those effects predicted to remain after the application of the Wildlife Management and Monitoring Plan (Section 29.21). Two potential effects (as predicted in Section 18.6.2) are predicted to have residual effects on mountain goats after mitigation: sensory disturbance and indirect mortality (Table 18.7-3).

### *18.7.2.1 Residual Effects of Sensory Disturbance on Mountain Goats*

### Residual Effect Characterization

Auditory and visual disturbance to mountain goats, primarily due to helicopter and fixed-wing aircraft may result in the displacement of these goats from adjacent habitats. The population of goats may be affected as they move away from noise through density-dependent effects and via some increase in the probability of mortality or reduced reproduction for individuals unfamiliar with predation risks and foraging opportunities in the new range.

**Table 18.7-3. Summary of Residual Effects on Mountain Goats**

Residual Effects	Evaluation Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Geographic Extent (local, landscape, regional, beyond regional)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Ecological Context (low, neutral, high)			
Disruption of Movement	Low	Landscape	Long-term	Sporadic	Reversible short-term	Neutral	Neutral	Medium	Not significant	Medium
Indirect Mortality	Low	Landscape	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	Low	Not significant	Medium
Overall Effects	Low	Landscape	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium

Noise disturbance from helicopters during Construction and from fixed-wing aircraft during Operation are rated to result in a low-magnitude effect on mountain goats, as less than 10% (8.5 to 9.5%) of the goats within the RSA are predicted to be exposed to noise levels that may cause disturbance.

The extent of the effect is landscape, as the noise disturbance extends beyond the Project footprint. The duration will be long term, as the noise disturbance will be removed at the end of the Operation phase. The frequency is sporadic, as air traffic will occur for a short time when it occurs. The effect of sensory disturbance is reversible short term, as the sound from helicopters and aircraft ends relatively quickly. The context of the mountain goat population is neutral.

#### Likelihood of Residual Effect

The probability of the effect occurring is medium (i.e., it is likely, but may not occur).

#### Significance of Residual Effect

The effect of sensory disturbance for mountain goats is assessed as **not significant**.

#### Characterization of Confidence

The confidence in this assessment is medium, as the response of mountain goats to sensory disturbance is relatively well known in the scientific literature, but can vary depending on habitat quality.

#### *18.7.2.2 Residual Effects of Indirect Mortality on Mountain Goats*

##### Residual Effect Characterization

The potential source of indirect mortality identified for mountain goats in association with Project development is an increase in hunting pressure resulting from greater accessibility to the Project area. Project roads and the transmission line may facilitate access to the alpine areas (BAFA BEC zone).

During Construction, Operation, and Closure, mitigation will include actively controlling access on Project roads to minimize unauthorized entry. A potential adverse residual effect of low magnitude is predicted for mountain goats because mortality from hunting is likely to be minor with mitigation, and hence within the limits of natural variation.

The geographic extent of the effect will be landscape, as it will extend beyond the footprint, but remain tied to the access road and transmission line access. The duration will be long term; although the roads and transmission line will be decommissioned, access via snowmobile and ATV may still be possible for a number of years following closure. The frequency will be sporadic. The effect is reversible long term with mitigation. The context of the mountain goat population is considered to be neutral.

#### Likelihood of Residual Effect

The probability of indirect mortality occurring is low due to mitigation measures.

#### Significance of Residual Effect

The effect of indirect mortality of mountain goats due to increased hunting pressure is assessed as **not significant**.

#### Characterization of Confidence

Because of mitigation, the confidence is medium because the actual number of hunters who could use these areas and the associated effect on the local mountain goat population is uncertain.

### 18.7.2.3 *Residual Overall Effects on Mountain Goats*

#### Residual Overall Effect Characterization

The residual effects for mountain goats are sensory disturbance and indirect mortality. These two effects may interact, creating additive or synergistic effects that have a different extent for the local mountain goat population as a whole.

Considering these potential effects on mountain goats in combination with mitigation to minimize effects, the overall potential Project-related residual effect on local mountain goat populations is rated as low magnitude. This assessment is largely driven by the relatively small area of noise disturbance, the low probability of indirect mortality occurring, and by the planned mitigation.

The extent will be landscape and the duration will be long term. The frequency will be sporadic. The effect will be reversible long term because the level of effects will decline at Closure. The context and resiliency of the population is considered neutral.

#### Likelihood for Residual Effects

The probability of an overall residual effect is medium, as it is likely but may not occur.

#### Significance of Overall Residual Effects

The overall residual effect of sensory disturbance and indirect mortality acting synergistically on mountain goats is assessed as **not significant**.

#### Characterization of Confidence

The assessment of the overall residual effects is of medium confidence because there is a low degree of confidence in most of the residual effects for goats.

### 18.7.3 **Residual Effects Assessment for Grizzly Bears**

Residual effects are those effects predicted to remain after the application of Wildlife Management and Monitoring Plan (Section 29.21). Four potential effects (as predicted in Section 18.6.3) are predicted to have residual effects on grizzly bears after mitigation: sensory disturbance, indirect mortality, disruption to movement, and direct mortality (Table 18.7-4).

#### 18.7.3.1 *Residual Effects of Disruption of Movement on Grizzly Bears*

#### Residual Effect Characterization

The Brucejack Access Road, site roads and infrastructure may act as barriers to grizzly bear movements, reducing connectivity between seasonal habitats. Grizzly bears frequently alter their behaviour and avoid areas with human activity and periods when humans are most active (C. M. Mueller 2001). Despite mitigation, movement to important high-quality habitat areas will likely be impeded in some locations along the access road and so a residual effect was found for grizzly bear disruption of movement.

The magnitude of grizzly bear disruption of movement is considered to be of low magnitude. The primary barrier to movement will be traffic along the access road, which may disrupt baseline movement patterns; however, bears will not be prevented from crossing roads, as the number of vehicles on the road (3.6 VPH) will remain below a threshold value of 10 VPH. The geographic extent of the effect will be landscape because disruption of movement will be tied to infrastructure and individuals within the watershed.

**Table 18.7-4. Summary of Residual Effects on Grizzly Bears**

Residual Effects	Evaluation Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Geographic Extent (local, landscape, regional, beyond regional)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Ecological Context (low, neutral, high)			
Disruption of Movement	Low	Landscape	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium
Direct Mortality	Low	Landscape	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium
Indirect Mortality	Low	Landscape	Far future	Sporadic	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium
Attractants	Low	Local	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	High	Not significant	High
Overall Effects	Moderate	Landscape	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium

The duration will be long term (i.e., for the duration of use of the access road), and the frequency sporadic, as the effect will occur at intermittent intervals. The effect will be reversible long term, as traffic will cease when the road is deactivated during the Post-closure phase. The ecological context of grizzly bears is considered to be neutral (and resiliency neutral); although they have large seasonal movement requirements, they are part of a viable regional population, high-quality habitat is abundant in the RSA, and movement in many parts of the RSA will be unaffected (for example, bear travel routes to the salmon-bearing Unuk River will remain undisturbed).

#### Likelihood for Residual Effects

The probability of the disruption to grizzly bear movement occurring is medium due to the large movements that grizzly bears typically undertake to access seasonal high-quality habitats.

#### Significance of Residual Effect

The effect of disruption of grizzly bear movement is assessed as **not significant**.

#### Characterization of Confidence

The confidence in the residual effects of disruption of movement on grizzly bears is medium because predicting bear movement patterns cannot be done with high confidence; however, scientific studies have shown that roads do act as barriers to grizzly bear movements when traffic exceeds 10 vehicles per hour (McLellan and Shackleton 1988; Ross 2002; Waller and Servheen 2005). Grizzly bears in the east portion of the RSA are likely to encounter Project-related infrastructure as they move between restricted high-quality foraging areas throughout the seasons and there is a moderate degree of uncertainty about their responses. Greater than 20 bears were detected within 10 km of the access road and baseline studies confirmed that grizzly bears move across the road alignment ([Appendix 18-A](#), 2013 Wildlife Characterization Baseline Report), but true spatial and temporal movement patterns within the RSA are not known for the local grizzly bear population.

#### *18.7.3.2 Residual Effects of Direct Mortality on Grizzly Bears*

##### Residual Effect Characterization

Direct grizzly bear mortality due to vehicle collisions is a potential residual effect because of the traffic along Project roads (access and site roads). Potential Project-related vehicle interactions with bears will be mitigated by setting and adhering to speed limits, road and traffic signs, cutting vegetation low at locations where bears tend to cross roads to ensure visibility of animals, and removing roadside carrion that may attract bears to the Project access road.

The magnitude of grizzly bear direct mortality is predicted to be low because mitigation, monitoring, and adaptive management will be conducted to identify high-risk locations along the access road. Grizzly bear mortality levels are not anticipated to reach a value that would detrimentally affect populations within the RSA. Incidental traffic mortality may occur as a result of the Project but those areas along the access road will be identified as requiring additional preventative mitigation measures. The extent of this effect will be landscape because it extends to the watershed but remains tied to the Project footprint. The duration will be long term because traffic volumes will be reduced during the Post-closure phase. The frequency will be sporadic. The effect will be reversible long term when traffic is reduced at Closure and eliminated when the road is reclaimed. The ecological context of grizzly bears is considered to be neutral (and resiliency neutral) because grizzly bears are provincially blue-listed and federally identified as a species of Special Concern by COSEWIC (BC CDC 2013); however, the regional population is sustainable (Hamilton, Heard, and Austin 2004; Hamilton 2012). It is not

anticipated that residual direct mortality effects will significantly affect the viability of the regional grizzly bear population.

#### Likelihood for Residual Effect

The probability of direct mortality occurring is medium. The likelihood for mortality incidents along the access road will be mitigated in advance and in response of incidents. High risk areas along the road and sensitive times of the year will be identified to further prevent mortality. For example, September and August typically pose the highest risk to grizzly bears with respect to vehicle collisions because they occupy habitat at low elevation (e.g., fish habitat); these times of year will be noted and communicated as particularly high risk for vehicular collisions with grizzly bears along the applicable stretches of the road which parallel the Bowser River and Wildfire Creek.

#### Significance of Residual Effect

With mitigation and monitoring, the residual effect of direct mortality for grizzly bears is **not significant**. The rate of vehicle-wildlife collisions has been correlated with traffic speeds, which will be below identified threshold limits along the access road (Seiler 2005); therefore, direct mortality is not anticipated to affect the viability of the local or regional grizzly bear populations (Hamilton, Heard, and Austin 2004; Hamilton 2012).

#### Characterization of Confidence

The confidence in the residual effects of direct mortality on grizzly bears is medium. Although it is clearly understood that traffic poses a risk to grizzly bear survival and the access road is both within and between high-quality habitat areas, it is not yet approximately known how many, when, or where bears need to cross the access road. It is expected that with low speed limits, mortality of bears will be very low, but the actual number of bears cannot be predicted with accuracy.

#### *18.7.3.3 Residual Effects of Indirect Mortality on Grizzly Bears*

##### Residual Effect Characterization

The potential source of indirect mortality identified for grizzly bears in association with Project development is an increase in hunting pressure and human activity resulting from greater accessibility. Mortality for grizzly bears can increase through a combination of unregulated hunting and incidental mortality when hunters defend their catches. Mitigation will include access control on the Brucejack Access Road for the life of the Project and reclamation of the road during Post-closure, minimizing the magnitude of the effect.

The magnitude of grizzly bear indirect mortality is low because access control should largely prohibit most hunting (both regulated and illegal), within the RSA. The geographic extent of grizzly bear indirect mortality is landscape because although it remains tied to the footprint (access road and transmission line), the effect may extend outside the Project footprint into high-quality habitat that may be accessed by foot from the access road. The duration of grizzly bear indirect mortality is far future because after reclamation of the access road and transmission line ROW, access via snowmobile and ATV may still be possible for several years. The frequency of grizzly bear indirect mortality is sporadic and the reversibility is reversible long term through planned mitigation. The ecological context of grizzly bears is considered to be neutral (and resiliency neutral) because grizzly bear populations in the area are relatively stable (Hamilton 2012); access may increase opportunities for hunting but not to the extent where the viability of local grizzly bear populations would be affected.

### Likelihood for Residual Effects

The probability of this effect is rated as medium because it is likely that the effect will occur, but it may not.

### Significance of Residual Effect

With mitigation and monitoring, the residual effect of indirect mortality on grizzly bears is assessed as **not significant**. Indirect grizzly bear mortality as a result of the Project will not impair the viability of local or regional populations due to the implementation of access control measures.

### Characterization of Confidence

The confidence of indirect mortality for grizzly bears is medium because although access will be controlled, predicting the effectiveness of the controlled access and predicting behaviour of hunters and their potential effect on the local bear populations is uncertain.

#### *18.7.3.4 Residual Effects of Attractants on Grizzly Bears*

### Residual Effect Characterization

Grizzly bears will be attracted to the odours from human activity within the Project footprint, such as camps, waste, or carrion along roads. Grizzly bear attraction can sometimes lead to destruction of problem bears. To minimize the effects of attractants to grizzly bears, mitigation measures will be implemented, including storing and removing all food wastes and wildlife attractants (e.g., liquid solvents, lubricants), erecting bear fences in appropriate areas, removing carrion from roads, educating employees and contractors in wildlife awareness, and monitoring waste management.

With mitigation, the magnitude of the effect of attractants is rated as low. Residual effects will be below threshold values and it is anticipated that problem bears will be managed accordingly so that most do not require translocation or destruction. The geographic extent of grizzly bear attractants is local because the effect is directly associated with Project activities and infrastructure areas. The duration is long term because there is the potential for attractants to be an effect as long as people are using Project infrastructure. Camps may remain open into the Post-closure phase if monitoring requirements persist. The frequency of grizzly bears being attracted to Project infrastructure will be sporadic during any phase of the Project. The reversibility is long term because when the Project is complete and reclamation and closure activities have ensured there are no longer any Project-related attractants within the Project footprints, the effect will no longer exist. The ecological context of grizzly bears is neutral (and resiliency neutral).

### Likelihood for Residual Effects

The probability of the effect occurring is high because bears are known to be attracted to camps because of odours, plastics and solvents, and waste from human activity (McLellan 1990; Blood 2001, 2002; COSEWIC 2002b). The likelihood for mortality incidents as a result of problem bears is low, as this effect will be mitigated in advance and in response to incidents with appropriate measures included in the Waste Management Plan (Section 29.17).

### Significance of Residual Effect

With mitigation and monitoring, the residual effect of attractants on grizzly bears is assessed as **not significant**. Mitigation measures are anticipated to resolve the effect of attractants in the long term as grizzly bears have been shown to maintain a high survival rate near human developments when proper mitigation occurs (Ciarniello 1997; H. Davis, Wellwood, and Ciarniello 2002).

Characterization of Confidence

The confidence in the assessment is high because the issues surrounding bears and attractants in remote areas are relatively well understood.

*18.7.3.5 Residual Overall Effects on Grizzly Bears*Residual Overall Effect Characterization

The residual effects for bears are disruption of movement, direct mortality, indirect mortality, and attractants. These individual effects were assessed for an overall effect based on their potential to interact, creating additive or synergistic effects that would have a different nature or extent for local grizzly bear populations as a whole.

The overall potential Project-related residual effect on local grizzly bear populations may cause a shift from baseline conditions that may or may not be detectable but will not cross a significant threshold or adversely affect the viability of the local population. Therefore, the magnitude of the potential for overall effects is rated as moderate. The extent will be landscape and the duration will be long term. The frequency will be sporadic. The effect will be reversible long term because the level of effects will decline at Closure. The overall ecological context of grizzly bears is neutral (and resiliency neutral).

Likelihood for Residual Effects

The probability of an overall residual effect on the grizzly bear population within the RSA is medium, because an effect is likely, but it may not occur.

Significance of Overall Residual Effects

The overall residual effect of disruption of movement, direct mortality, indirect mortality, and attractants acting synergistically on grizzly bears is assessed as **not significant**.

Characterization of Confidence

The assessment of the overall residual effects is of medium confidence because there is a medium level of confidence in most of the residual effects for grizzly bears.

**18.7.4 Residual Effects Assessment for American Marten**

Residual effects are those effects predicted to remain after the application of Wildlife Management and Monitoring Plan (Section 29.21). One potential effect (as predicted in Section 18.6.4) is predicted to have a residual effect on American marten after mitigation: attractants (Table 18.7-5).

*18.7.4.1 Residual Effects of Attractants on Marten*Residual Effect Characterization

Marten may be attracted to the odours from human activity within the Project footprint, such as camps, waste, and infrastructure for shelter and prey sources. To minimize the effects of attractants to marten, mitigation measures will be implemented, including: waste incineration and/or shipping off-site where incineration is not possible; storage of recyclables and wastes in wildlife-proof storage containers and facilities; proper storage and disposal of hazardous wastes; removal of waste from collection sites regularly and incineration in an approved incinerator as soon as possible; installation of exclusion fencing at cooking areas, refuse storage areas, and sewage treatment/waste water facilities; securing all buildings with skirting to prevent access; and regular inspections of camp and Project infrastructure for sign of marten.

**Table 18.7-5. Summary of Residual Effects on American Marten**

	Evaluation Criteria							Likelihood <i>(low, medium, high)</i>	Significance of Adverse Residual Effects <i>(not significant, significant)</i>	Confidence <i>(low, medium, high)</i>
	Magnitude <i>(low, moderate, high)</i>	Geographic Extent <i>(local, landscape, regional, beyond regional)</i>	Duration <i>(short-term, medium-term, long-term, far future)</i>	Frequency <i>(once, sporadic, regular, continuous)</i>	Reversibility <i>(reversible short-term, reversible long-term, irreversible)</i>	Resiliency <i>(low, neutral, high)</i>	Ecological Context <i>(low, neutral, high)</i>			
Residual Effects										
Attractants	Low	Local	Long-term	Sporadic	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium

With mitigation and monitoring, the effect is assessed as low magnitude. The geographic extent is local because the effect is directly associated with Project activities and infrastructure areas. The duration is long term because there is the potential for attractants to be an effect as long as people are using Project infrastructure. Camps may remain open into the Post-closure phase if monitoring requirements persist. The frequency of American marten being attracted to Project infrastructure will be sporadic during any phase of the Project. The degree of reversibility of American marten attractants is reversible long term because when reclamation and closure activities have ensured there are no longer any Project-related attractants within the Project footprints, the effect will no longer exist. The ecological context of American marten is neutral.

#### Likelihood for Residual Effects

The probability of the effect occurring is high because American marten are known to be attracted to Project features by odours, shelter, food, and prey (Ruggiero et al. 1994).

#### Significance of Residual Effect

The residual effect of attractants on American marten was assessed as **not significant** because although it is anticipated that some individuals will modify their behaviour as a result of Project attractants, mitigation measures are anticipated to resolve the effect of attractants in the long term.

#### Characterization of Confidence

The confidence of the effect is medium, because although marten are likely to be attracted to odours and Project infrastructure, the effectiveness of mitigation may eliminate this effect.

### **18.7.5 Residual Effects Assessment for Western Toads**

Residual effects are those effects predicted to remain after the application of the Wildlife Management and Monitoring Plan (Section 29.21). One potential effect (as predicted in Section 18.6.10) is predicted to have residual effect on western toads after mitigation: direct mortality (Table 18.7-6).

#### *18.7.5.1 Residual Effects of Direct Mortality on Western Toads*

#### Residual Effect Characterization

The residual effect of direct mortality on western toads is due to the risk of vehicle-toad collisions when toads are crossing roads to access breeding ponds. Due to the high concentration of wetlands adjacent to the access road, it is anticipated that there will be toad dispersal across the road, travelling to and from wetlands. To mitigate potential direct mortality effects on toads, pre-clearing surveys would be conducted on any ponds that would be affected by construction during the breeding (May) and emergence periods (mid-July to mid-August) to identify western toad breeding ponds. Use of machinery and associated Construction phase activities (i.e., tree felling) would be avoided at identified breeding ponds during those periods. Appropriate protection for toads will be provided, which may include toad tunnels or other effective mitigation to minimize the risk of vehicle collisions along the access road.

The magnitude of the effect of direct mortality on western toads is predicted to be low, as it is anticipated that the number of ponds which are used for breeding will be low and mitigation will reduce the magnitude of the effect. The extent is evaluated as local, as direct mortality would be tied to the access road. The duration will be long term, as the effect will be reduced after the life of the Project once vehicle traffic ceases on the access road, and direct mortality may occur sporadically. The effect will be reversible long term with adaptive mitigation. The context of western toads is considered high (and resiliency low), because they are listed on Schedule 1 of SARA.

**Table 18.7-6. Summary of Residual Effect on Western Toads**

Residual Effects	Evaluation Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Geographic Extent (local, landscape, regional, beyond regional)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Ecological Context (low, neutral, high)			
Direct Mortality and Injury	Low	Local	Long-term	Sporadic	Reversible long-term	Low	High	Medium	Not significant	Medium

Likelihood of Residual Effect

The likelihood of direct mortality occurring is medium.

Significance of Residual Effect

After mitigation and monitoring, the effect of direct mortality is assessed as **not significant** for western toads.

Characterization of Confidence

As some mortality is likely to occur, the confidence of the assessment is medium.

**18.8 SUMMARY OF RESIDUAL EFFECTS AND SIGNIFICANCE FOR WILDLIFE**

Table 18.8-1 provides a summary of residual effects, mitigation measures, and significance determinations for the residual effects for the five wildlife species identified in Section 18.7 above.

**Table 18.8-1. Summary of Residual Effects, Mitigation, and Significance on Wildlife**

Residual Effects	Project Phase(s)	Mitigation Measures	Significance
<b><i>Moose</i></b>			
Disruption of Movement	Construction and Operation	Traffic and road management, employee education, snow clearing protocol (e.g., gaps in snowbanks).	Not significant
Direct Mortality and Injury	Construction and Operation	Traffic and road management, vegetation management at identified wildlife crossings, and monitoring.	Not significant
Indirect Mortality	Construction, Operation and Closure/Post Closure	Minimize development of new roads, control access on existing Project roads, and monitoring.	Not significant
<b><i>Mountain Goat</i></b>			
Sensory Disturbance	Construction and Operation	Practice the current BC guidelines for air traffic near mountain goat habitat.	Not significant
Indirect Mortality	Construction, Operation and Closure/Post Closure	Limit road access to employees with no public access.	Not significant
<b><i>Grizzly Bear</i></b>			
Disruption of Movement	Construction and Operation	Traffic and road management, employee education	Not significant
Direct Mortality and Injury	Construction and Operation	Traffic and road management, vegetation management at identified wildlife crossings, and monitoring.	Not significant
Indirect Mortality	Construction, Operation and Closure/Post Closure	Restrict road access, controlled gate at Highway 37 intersection to deter trespassers.	Not significant
Attractants	Construction and Operation	Wildlife Management and Monitoring Plan, Waste management protocol, employee education, and plant less attractive roadside vegetation.	Not significant
<b><i>American Marten</i></b>			
Attractants	Construction and Operation	Waste management protocol and deterring entry into infrastructure.	Not significant
<b><i>Western Toad</i></b>			
Direct Mortality and Injury	Construction and Operation	Pre-clearing surveys, monitoring and management plans, amphibian tunnels and culverts, and adaptive management.	Not significant

## 18.9 CUMULATIVE EFFECTS ASSESSMENT FOR WILDLIFE

Cumulative effects are defined in this Application/EIS as “effects which are likely to result from the designated project in combination with other projects and activities that have been or will be carried out.” This definition follows that in section 19(1) of the *Canadian Environmental Assessment Act, 2012* (2012a) and is consistent with the IFC Good Practice Note on Cumulative Impact Assessment (ESSA Technologies Ltd. and IFC 2012) which refers to consideration of other existing, planned and/or reasonably foreseeable future projects and developments (Figure 18.9-1). CEA is a requirement of the AIR and the EIS Guidelines and is necessary for the proponent to comply with the *Canadian Environmental Assessment Act, 2012* (2012a) and the *BC Environmental Assessment Act* (2002a).

The Canadian Environmental Assessment Agency issued an Operational Policy Statement in May 2013 entitled *Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act 2012* (CEA Agency 2013), which provides a method for undertaking CEA. Recently, the BC EAO also released the updated *Guideline for the Selection of Valued Components and the Assessment of Potential Effects* (BC EAO 2013), which includes advice for determining the need for a cumulative impact assessment. The CEA methodology adopted in this Application/EIS therefore follows the guidance of the Canadian Environmental Assessment Agency as outlined above, as well as the selection criteria in BC EAO (2013).

The CEA considers the effects on wildlife and wildlife habitat that are likely to result from the residual environmental effects of the Project in combination with the effects of other projects and activities that have been or are likely to be carried out in the same area as the Project. The method involves the following key steps which are further discussed in the following sub-sections:

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

### 18.9.1 Establishing the Scope of the Cumulative Effects Assessment

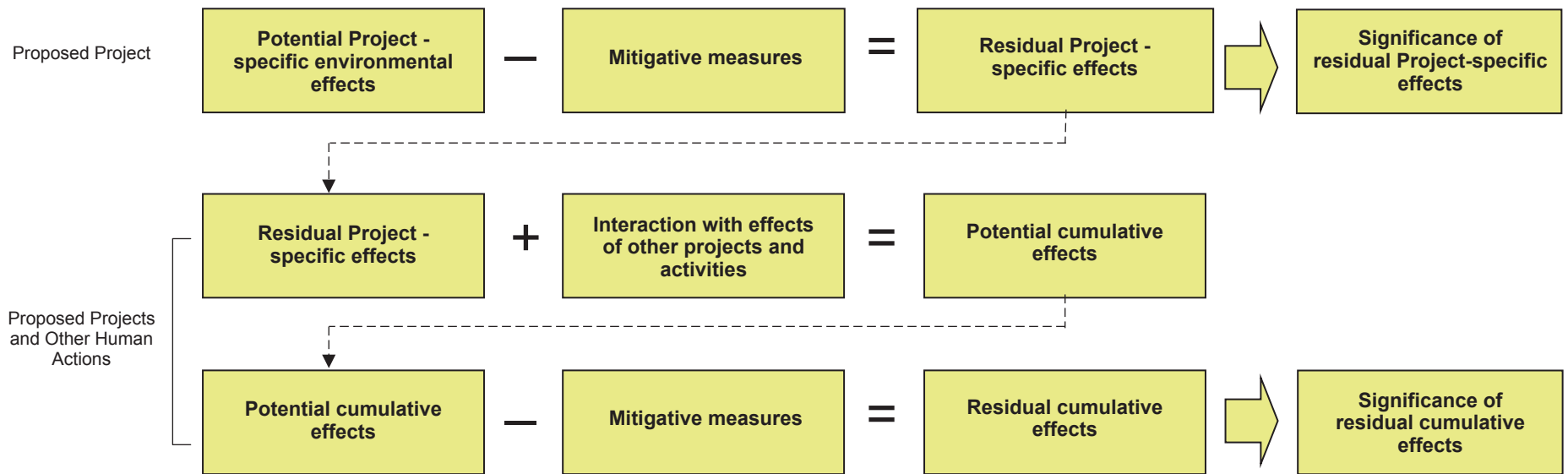
The scoping process involves identification of the receptor VCs for which residual effects are predicted, definition of the spatio-temporal boundaries of the assessment, and an examination of the relationship between the residual effects of the Project and those of other projects and activities.

#### 18.9.1.1 Identifying Receptor Valued Components for the Cumulative Effects Assessment

Receptor VCs included in the wildlife CEA were selected using four criteria following the BC EAO (2013):

- there must be a residual environmental effect of the Project;
- that environmental effect must be demonstrated to interact cumulatively with the environmental effects from other projects or activities;
- it must be known that the other projects or activities have been or will be carried out and are not hypothetical; and
- the cumulative environmental effect must be likely to occur.

**Figure 18.9-1**  
**Approach to Cumulative Assessment**



The CEA is organized by VC, as each VC is influenced by different projects, over different spatial and temporal scales. Wherever possible, the CEA uses quantitative information and thresholds/land use objectives; however, in cases where quantitative assessment is not possible due to insufficient regional information, or where thresholds or land use objectives have not been developed for the species, a qualitative assessment is used.

The potential residual effects for all 10 wildlife VCs considered in the Application/EIS are summarized in Table 18.9-1. The residual effects marked with a “Y” in Table 18.9-1 were carried forward into the CEA, where other projects that may interact with these effects for VCs on a larger spatial scale are considered. The CEA considers the potential for cumulative effects on the following five wildlife VCs that were predicted to experience residual effects:

- moose;
- mountain goat;
- grizzly bear;
- American marten; and
- western toad.

**Table 18.9-1. Residual Effects Predicted from the Wildlife Application/EIS**

VC	Habitat Loss/ Alteration	Sensory Disturbance	Disruption of Movement	Direct Mortality	Indirect Mortality	Attractants	Chemical Hazards
Moose	N	N	Y	Y	Y	N	N
Mountain goat	N	Y	N	N	Y	N	N
Grizzly bear	N	N	Y	Y	Y	Y	N
American marten	N	N	N	N	N	Y	N
Hoary marmot	N	N	N	N	N	N	N
Bats	N	N	N	N	N	N	N
Raptors	N	N	N	N	N	N	N
Migratory waterbirds	N	N	N	N	N	N	N
Migratory landbirds	N	N	N	N	N	N	N
Western toad	N	N	N	Y	N	N	N

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

**18.9.1.2 Potential Interaction of Projects and Activities with the Brucejack Gold Mine Project for Wildlife**

A review of the interaction between potential effects of the Project and effects of other projects and activities on wildlife was undertaken. The review assessed the projects and activities identified in Section 6.8.2 of the Assessment Methodology, including:

- regional projects and activities that are likely to affect the receptor VC, even if they are located outside the direct zone of influence of the project;
- effects of past and present projects and activities that are expected to continue into the future (i.e., beyond the effects reflected in the existing conditions of the receptor VC); and

- o activities not limited to other reviewable projects, if those activities are likely to affect the receptor VC cumulatively (e.g., forestry, mineral exploration, commercial recreational activities).

A matrix identifying the potential cumulative effect interactions for wildlife VCs is provided in Table 18.9-2 below.

**Table 18.9-2. Potential Cumulative Effect Interactions for Wildlife**

Projects and Activities	Wildlife Receptor VCs				
	Moose	Mountain Goat	Grizzly Bear	American Marten	Western Toads
<b>Historical</b>					
Eskay Creek Mine	■	■	■	■	■
Galore Creek Mine - Access Road Only	■	■	■	■	■
Goldwedge Mine	■	■	■	■	■
Granduc Mine (Past Producer)	■	■	■	■	■
Johnny Mountain Mine	■	■	■	■	■
Kitsault Mine (Past Producer)	■	■	■	■	■
Silbak Premier Mine	■	■	■	■	■
Snip Mine	■	■	■	■	■
Snowfield Exploration Project	■	■	■	■	■
Sulphurets Advanced Exploration Project	■	■	■	■	■
Swamp Point Aggregate Mine	■	■	■	■	■
<b>Present</b>					
Forrest Kerr Hydroelectric Power Facility	■	■	■	■	■
Long Lake Hydroelectric Power Facility	■	■	■	■	■
McLymont Creek Hydroelectric Project	■	■	■	■	■
Northwest Transmission Line	■	■	■	■	■
Red Chris Mine	■	■	■	■	■
Brucejack Exploration Road	■	■	■	■	■
<b>Reasonably Foreseeable Future</b>					
Arctos Anthracite Coal Mine	■	■	■	■	■
Bear River Gravel Project	■	■	■	■	■
Bronson Slope Project	■	■	■	■	■
Coastal GasLink Pipeline Project	■	■	■	■	■
Galore Creek Mine	■	■	■	■	■
Granduc Copper Mine	■	■	■	■	■
KSM Project	■	■	■	■	■
Kinskuch Hydroelectric Project	■	■	■	■	■

(continued)

Table 18.9-2. Potential Cumulative Effect Interactions for Wildlife (completed)

Projects and Activities	Wildlife Receptor VCs				
	Moose	Mountain Goat	Grizzly Bear	American Marten	Western Toads
<i>Reasonably Foreseeable Future (cont'd)</i>					
Kitsault Mine			Black		
Kutcho Mine					
LNG Canada Export Terminal Project					
Northern Gateway Pipeline Project					
Prince Rupert Gas Transmission Project					
Prince Rupert LNG Project					
Schaft Creek Mine	Black	Black	Black		
Spectra Energy Gas Pipeline					
Storie Moly Mine					
Treaty Creek Hydroelectric Project	Black	Black	Black	Black	Black
Turnagain Mine					
Volcano Hydroelectric Project	Black	Black	Black		
<i>Land Use Activities - All Stages (past, present, future)</i>					
Parks and Protected Areas	Black	Black	Black		
Guide Outfitting	Black	Black	Black		
Aboriginal Harvest (hunting/trapping, plant gathering)	Black	Black	Black	Black	
Hunting	Black	Black	Black	Black	
Trapping	White	White	White	Black	
Commercial Recreation	Black	Black	Black	White	
Forestry	Black	Black	Black	Black	Black
Transportation	Black	Black	Black	White	Black

Notes:

Black = likely interaction between Brucejack Gold Mine Project and other project or activity  
 Grey = possible interaction between Brucejack Gold Mine Project and other project or activity  
 White = unlikely interaction between Brucejack Gold Mine Project and other project or activity

18.9.1.3 Spatio-temporal Boundaries of the Cumulative Effects Assessment

The CEA boundaries define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with the receptor VCs and with other projects and activities, as well as the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries), and limitations in predicting or measuring changes (technical boundaries). The definition of these assessment boundaries is an integral part of the wildlife CEA, and encompasses possible direct, indirect, and induced effects of the Project on wildlife.

### Spatial Boundaries

Spatial boundaries were chosen to evaluate the effects on individual animals and populations of animals. The effects on animals of wide-ranging species that may move outside of the RSA (e.g., moose, mountain goat, and grizzly bear) were examined by calculating two spatial boundaries: a Movement Area and a CEA Area. The Movement Area is defined as the distance away from the Project that an average animal of a particular species may travel in a year (e.g., maximum home range size or maximum linear distance travelled).

The CEA Area used provincial population boundaries, such as WMUs, or natural boundaries. Three main spatial scales were selected for the CEA Area:

1. The GBPU boundaries (the outer periphery of the three GBPUs that converge at the Project; used for grizzly bears).
2. The wildlife management area, used for moose and mountain goat, which consisted of three WMUs that converge at the Project (WMUs 6-21, 6-16, and 6-17).
3. The adjusted RSA based on the RSA used in the wildlife effects assessment, with species-specific adjustments to the RSA boundary based on home range size (used for American marten and western toad, which can move slightly farther than the original RSA boundary).

Further information on the rationale for the spatial boundaries and maximum range size calculations for each wildlife VC is outlined in Table 18.9-3. Figures 18.9-2 to 18.9-6 display the Movement Areas and the CEA Area used for examining effects on each VC.

After identifying the CEA and Movement areas for wildlife VCs, these areas were used to narrow the focus of the CEA. This was conducted in two ways: first, the projects and project components that fall outside of the CEA Area for each VC were scoped out of the assessment. Second, the elevations of all projects within the CEA Area for each VC were considered against the elevation ranges of each VC; projects within the CEA Area for each VC, but outside of their capable elevation range, were also eliminated. A summary of projects included and excluded for each VC is presented in Section 18.9.1.4 (Tables 18.9-4 to 18.9-13).

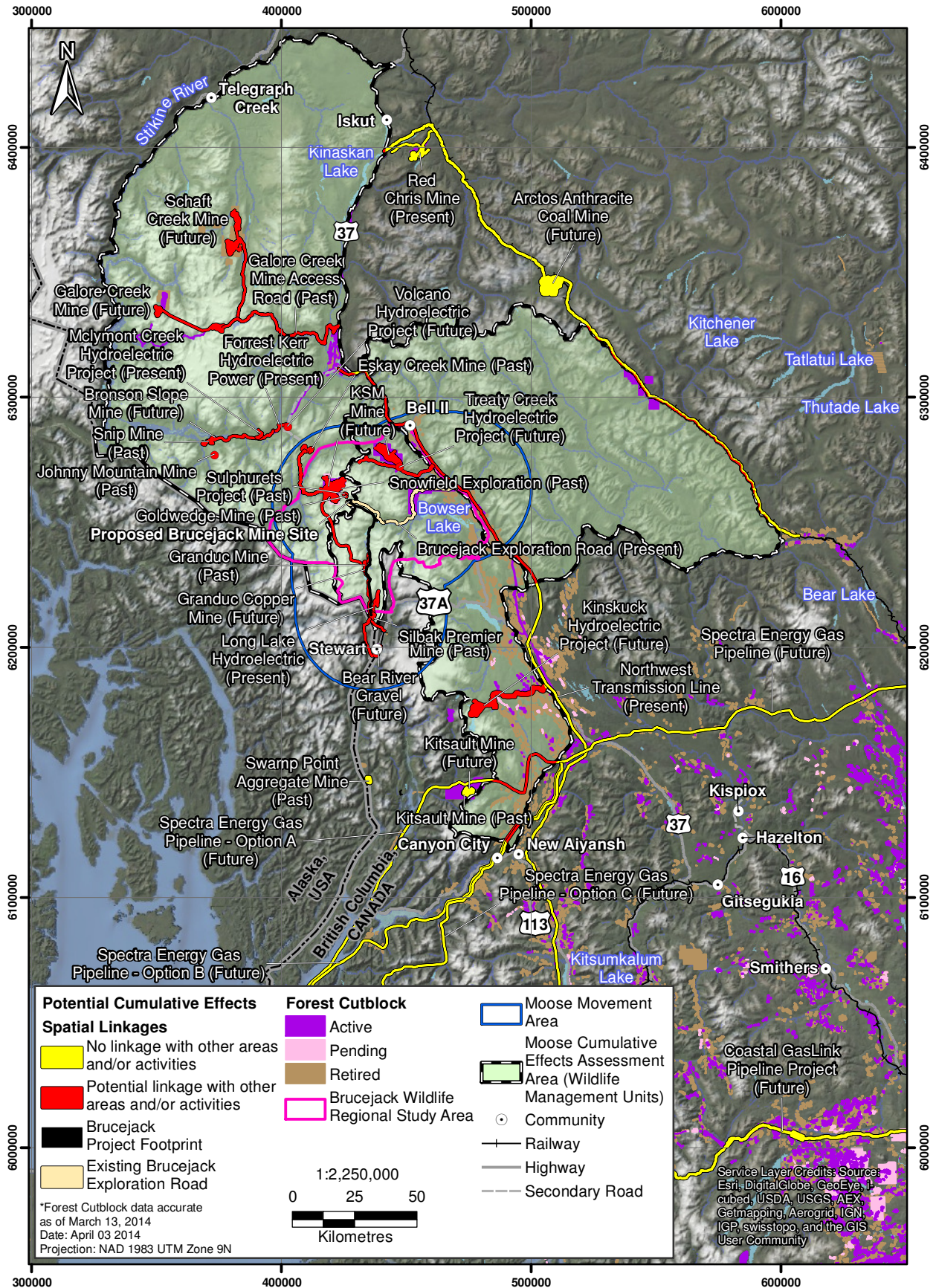
### Temporal Boundaries

The projects that were linked spatially with the Brucejack Gold Mine Project for each VC were also assessed for temporal linkages. The following time spans were used to define past, present, and future effects:

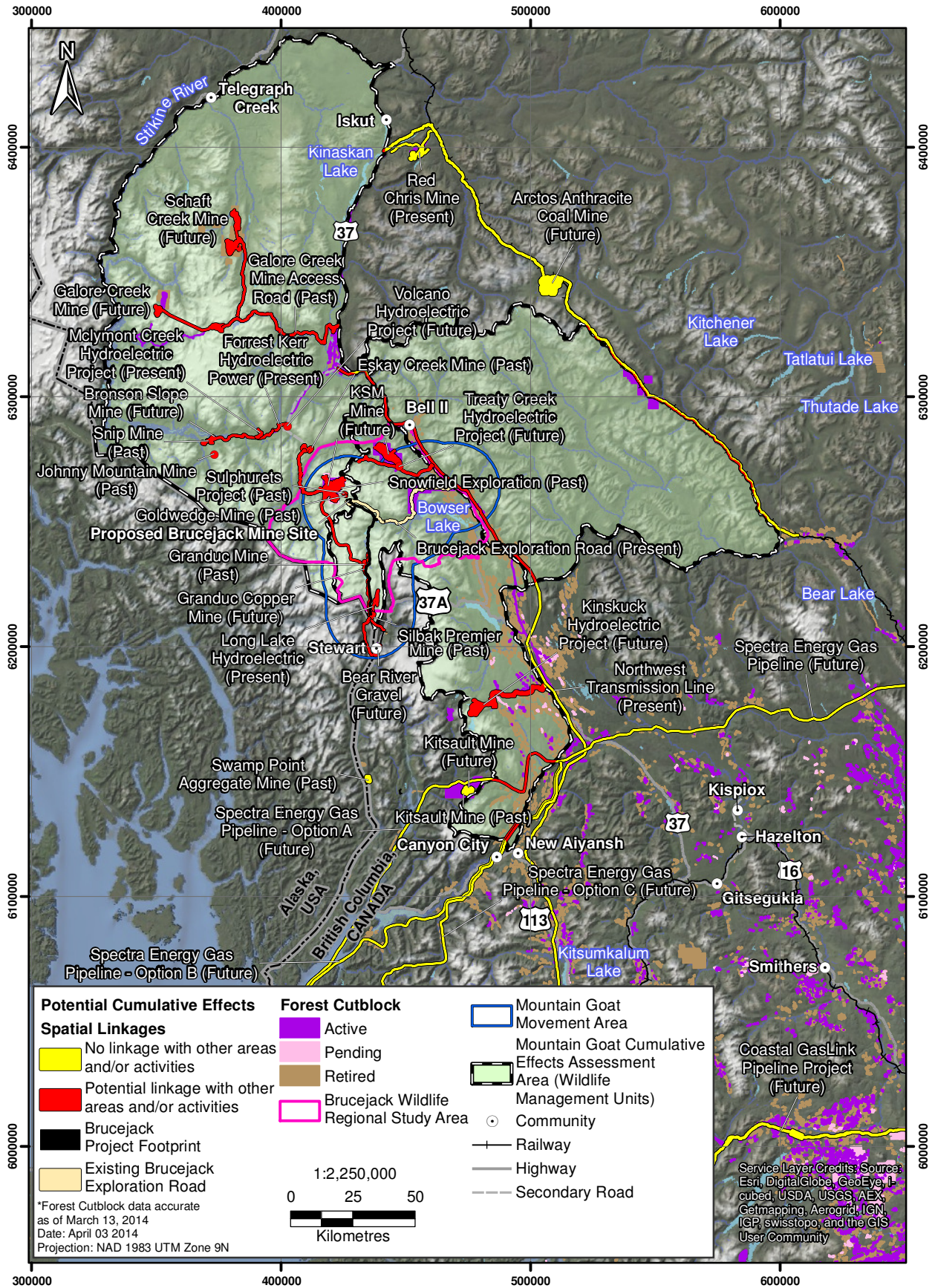
- **Past:** 1964 to 2009; coinciding with the development of the Granduc Copper-Gold Mine, which influenced the growth of the community of Stewart and other human activities in the area (StewartBC.com 2004);
- **Present:** 2010 to 2014; from the start of Brucejack Gold Mine Project baseline studies to the completion of the Application/EIS; and
- **Future:** variable according to the time estimated for VCs to recover to baseline conditions following the completion of the mine life of the Brucejack Gold Mine Project.

All spatially linked projects that clearly overlap the Construction and Operation phases of the Project were considered to be temporally linked in the CEA. Some past projects were still considered to be linked to the present (and sometimes future) conditions of certain VCs due to remaining infrastructure (e.g., roads), learned responses from wildlife (e.g., food attractants), or permanent/long lasting habitat alterations (e.g., roads, tailings management facilities).

**Figure 18.9-2**  
**Moose Cumulative Effects Assessment**  
**Area and Movement Area**



**Figure 18.9-3**  
**Mountain Goat Cumulative Effects Assessment**  
**Area and Movement Area**



**Figure 18.9-4**  
**Grizzly Bear Cumulative Effects Assessment**  
**Area and Movement Area**

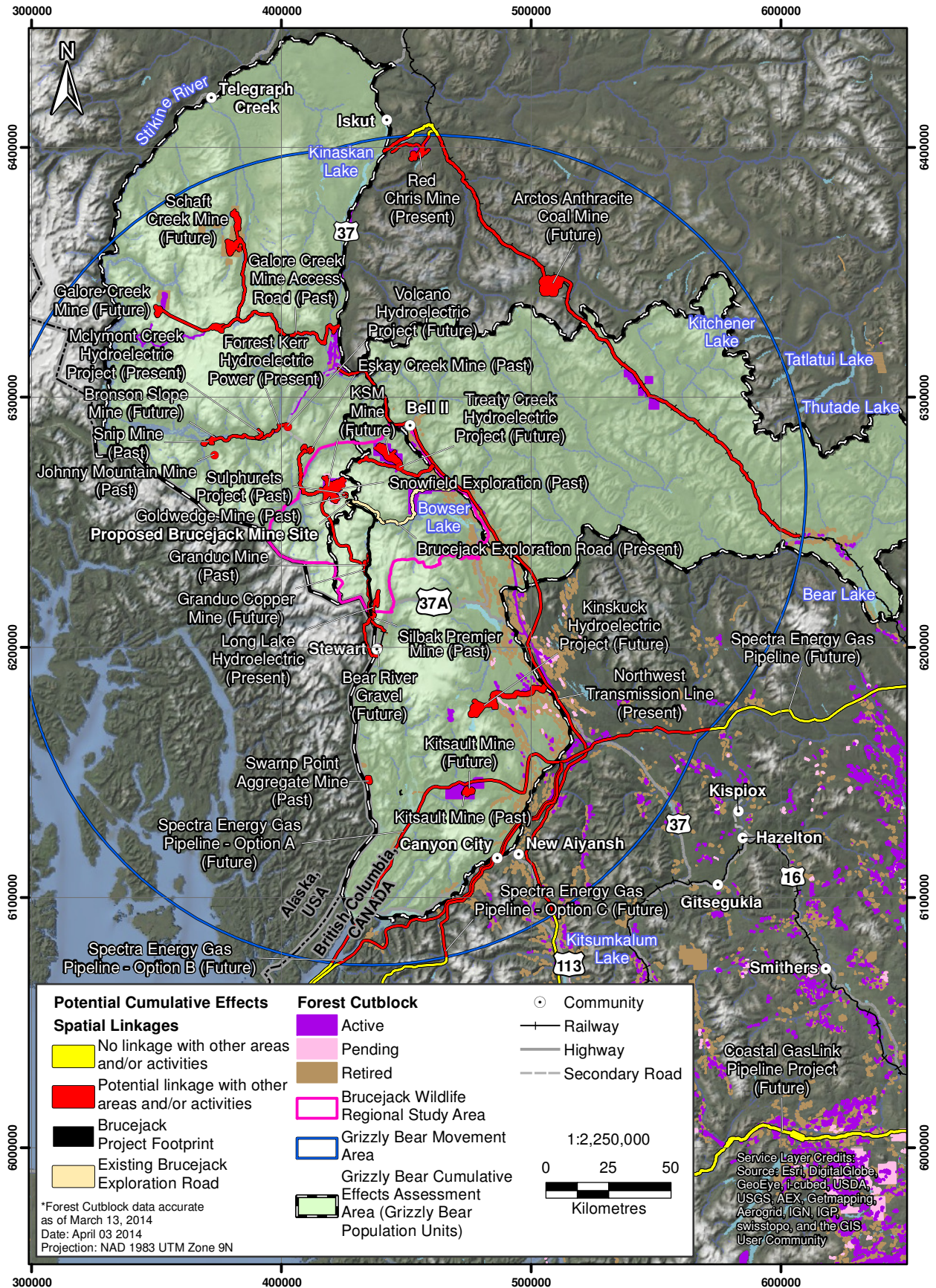


Figure 18.9-5

American Marten Cumulative Effects Assessment Area

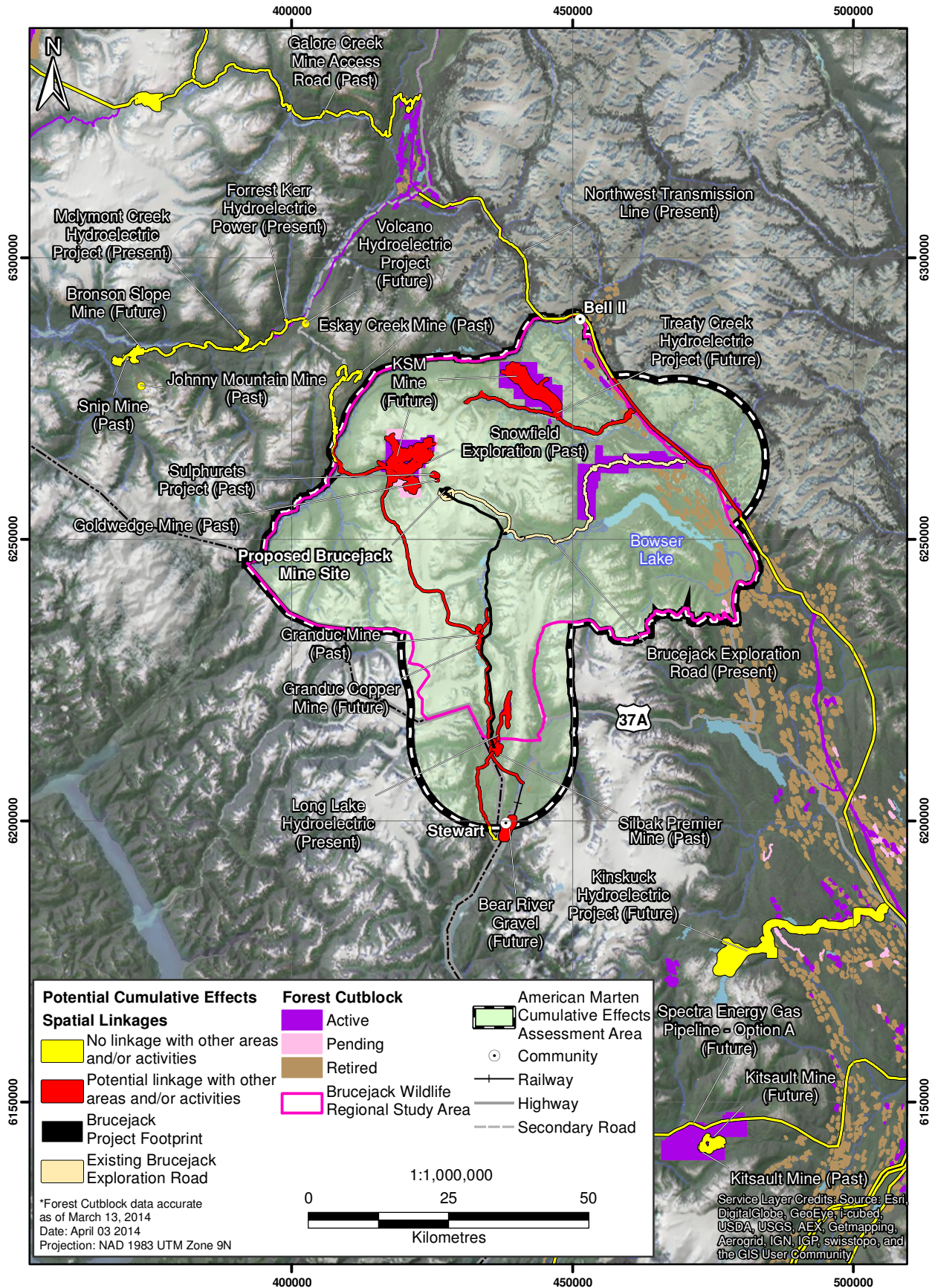


Figure 18.9-6

Western Toad Cumulative Effects Assessment Area

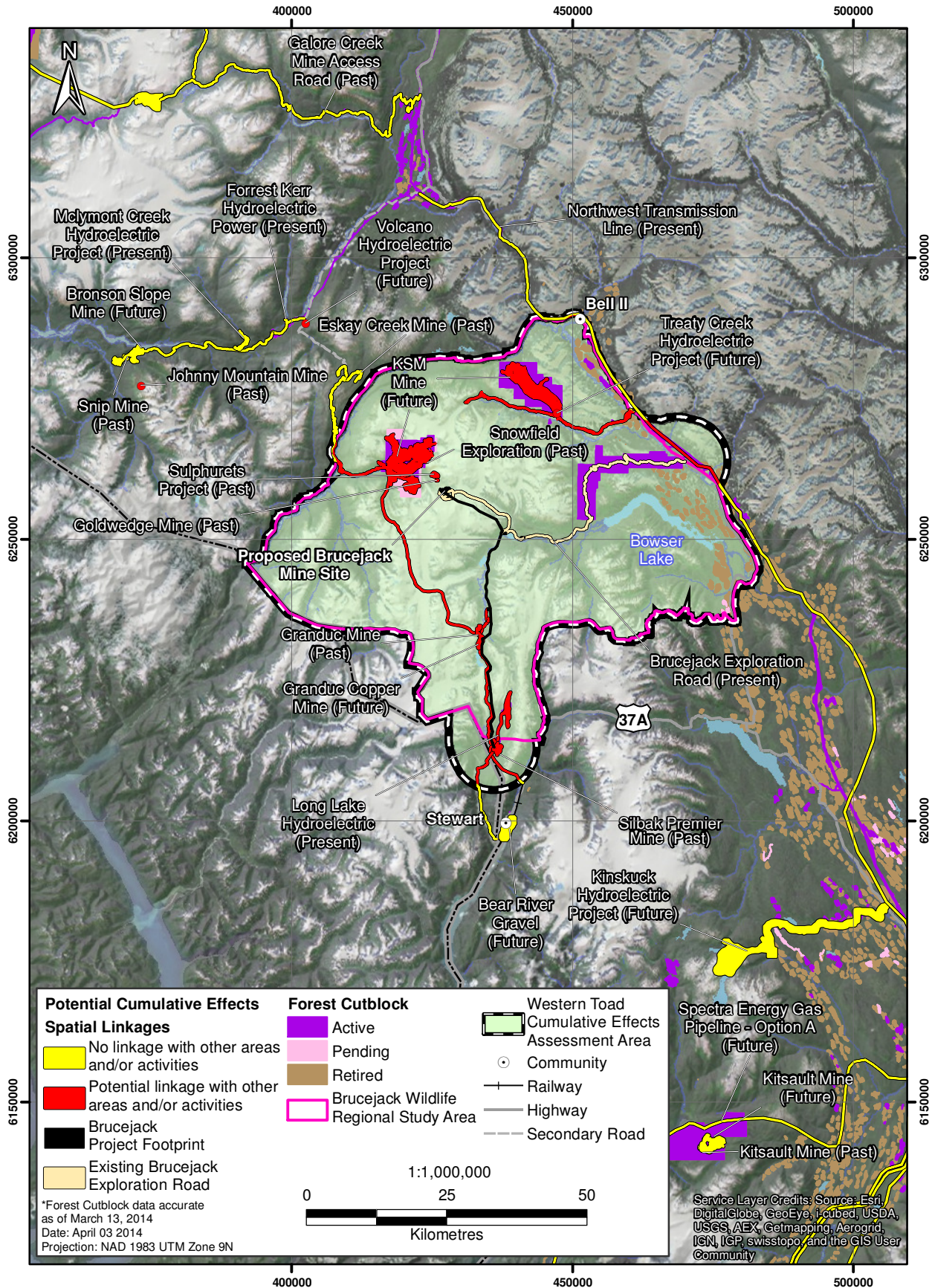


Table 18.9-3. CEA Area and Movement Area Rationale for Each Wildlife Valued Component

CEA Area	Used for	CEA Area (Used to Evaluate Effects on VC Populations)	Movement Area (Home Range; Used to Evaluate Effects on Individual Animals)	Figure
1. Wildlife Management Area	Moose	The wildlife management area boundary (which includes three WMUs: 6-21, 6-16, and 6-17) was used to consider cumulative impacts on moose populations, which require connectivity across large landscapes for gene flow and access to capable winter range. The WMU is used for regional management of moose, making it a logical assessment area to aid regulatory agencies in tracking and managing cumulative impacts on these VCs.	Migratory moose in the NWA have a mean multiannual home range of 218 km <sup>2</sup> while non-migratory moose have a mean multiannual home range of 42 km <sup>2</sup> (M. W. Demarchi 2000, 2003).  For the purposes of the CEA, all moose were assumed to be migratory, as this assumption resulted in a precautionary assessment. The square root of the migratory home range was taken (15 km). Moose movement within the region, however, is generally along narrow ranges of habitat features (e.g., valleys) rather than a simple square block of area due to the mountainous landscape which restricts suitable moose habitat to lower elevation riparian corridors. Therefore, rather than the square root of a migratory moose home range (15 km), the distance was doubled to reflect an expected more narrow and longer path of moose movement from the Project of 30 km. The 30-km buffer movement area encompasses the maximum number of projects that a moose could interact with, while still interacting with the Project.	18.9-2
	Mountain goat	The wildlife management area boundary (which includes three WMUs: 6-21, 6-16, and 6-17) was used to consider cumulative impacts on mountain goat populations, which require connectivity across large landscapes to promote gene flow in limited capable habitat (Ortego et al. 2011). The WMU is also used for regional management of mountain goats, making it a logical assessment area.	Typically, the largest distances travelled by mountain goats are made from their winter range to mineral licks. In a study in north-central BC, radio-collared goats travelled 3.6 to 10.6 km from their winter range to mineral licks (Corbould et al. 2010). One male travelled up to 60 km, but this appeared to be anomalous in the literature. In another study of goat movement in southeastern BC, Poole, Bachmann, and Teske (2010) recorded a maximum movement distance of 17.3 km by radio-collared mountain goats; this also falls within the upper range of distances observed by Hebert and Cowan (1971) .  A movement area boundary for mountain goat was therefore placed at 17.3 km from the Project, representing the maximum number of projects that a goat could interact with, while also interacting with the Project. As mountain goats require escape terrain, this area was fitted to the edge of capable habitat when it extended into non- capable habitat.	18.9-3

(continued)

**Table 18.9-3. CEA Area and Movement Area Rationale for Each Wildlife Valued Component (continued)**

CEA Area	Used for	CEA Area (Used to Evaluate Effects on VC Populations)	Movement Area (Home Range; Used to Evaluate Effects on Individual Animals)	Figure
2. GBPU Boundary	Grizzly bear	<p>The current range of grizzly bears in BC has been partitioned into GBPUs for conservation and management purposes. In northern and coastal BC, GBPU boundaries follow natural and ecological boundaries or transition areas (primarily height of land between watersheds) as there are few actual barriers to grizzly bear movement.</p> <p>Three GBPU boundaries converge at the Brucejack Project: The Edziza-Lower Stikine GBPU to the north, the Stewart GBPU to the south, and the Upper Skeena-Nass GBPU to the east. These three boundaries were combined into a CEA Area and were used to consider cumulative impacts on grizzly bears.</p>	<p>The Movement Area was determined with existing baseline and regional movement data. During baseline surveys at the Project, the average grizzly bear movement distance detected between sampling locations was 22.1 km and the maximum distance was 58.7 km, which was travelled by both a female and a male (Appendix 18-A). By comparison, the neighbouring KSM Project reported the maximum movement distance detected as 70 km from a male grizzly bear (Rescan 2010b). Regional studies estimated grizzly bear home ranges for coastal females at 52 km<sup>2</sup> (7.2 x 7.2 km), coastal males at 137 km<sup>2</sup> (11.7 x 11.7 km), interior females at 103 km<sup>2</sup> (10.1 x 10.1 km), and interior males at (187 km<sup>2</sup>; 13.6 x 13.6 km), which are more reflective of the average movement detections reported at the Project (Khutzeymateen; MacHutchon, Himmer, and Bryden 1993; Ciarniello 2006). Therefore a maximum linear movement distance for grizzly bears of 140 km was selected. This area represents the maximum number of projects that a grizzly bear could interact with, while also interacting with the Project.</p>	18.9-4
3. Adjusted RSA	American marten	<p>The CEA Area used for American marten is based on the RSA, but expands in some areas to account for the likely movement distances of American marten.</p> <p>American marten in south-central Alaska were reported to repeatedly travel 11 to 14 km between two areas of home range focal activity (Buskirk 1983). Slough (1994) reported that the mean final distances that American marten travelled from release sites were 13.4 km for males and 8.6 km for females. Therefore, a movement area for American marten of 14 km from the Project was added to the RSA boundary. This area represents the maximum number of projects that an individual American marten could interact with, while also interacting with the Brucejack Gold Mine Project. This area is the CEA Area used for American marten.</p>	<p>Not applicable to American marten. Only a CEA Area is used for the CEA for American marten.</p>	18.9.5

(continued)

**Table 18.9-3. CEA Area and Movement Area Rationale for Each Wildlife Valued Component (completed)**

CEA Area	Used for	CEA Area (Used to Evaluate Effects on VC Populations)	Movement Area (Home Range; Used to Evaluate Effects on Individual Animals)	Figure
3. Adjusted RSA ( <i>cont'd</i> )	Western toad	<p>The CEA Area used for western toad is based on the RSA, but expands in some sections due to maximum movement distances of western toad.</p> <p>The longest distance recorded for western toad movement is 7.2 km (Wind and Dupuis 2002). Therefore, an area for western toad was placed at a distance of 7.2 km from the Project footprint, representing the maximum number of projects that a western toad could interact with, while interacting with the Brucejack Gold Mine Project.</p> <p>The CEA boundary for western toads is 3,895 km<sup>2</sup>, 98% of which is within BC and 2% (76 km<sup>2</sup>) is in Alaska. For the purposes of the CEA, the Alaskan portion will not be included in the analyses due to jurisdictional reasons.</p>	Not applicable to western toads. Only a CEA Area is used for the CEA for western toads.	18.9.6

Brief explanations for temporal linkages among projects are provided in [Appendix 18-C](#), Summary of Potential Temporal Linkages between the Brucejack Gold Mine Project and other Human Actions for Wildlife. More detailed descriptions of all projects are found in Section 6.9.2 of Chapter 6, Assessment Methodology.

#### 18.9.1.4 Potential for Cumulative Effects

##### Potential for Cumulative Effects - Moose

Three potential residual effects are predicted to have cumulative effects on moose: disruption of movement, direct mortality, and indirect mortality from other historical, existing, and foreseeable future projects (Table 18.9-4). The type of potential cumulative effect is spatial crowding of projects or nibbling loss that is the gradual disturbance and loss of land and habitat (e.g., clearing of land for new roads into a forested area). A total of 19 projects were identified with both spatial and temporal overlap for the CEA for moose in the Project area. All projects identified with spatial overlap were assessed as having an associated temporal overlap as well. Some past projects were still considered to be linked to the present (and sometimes future) conditions of moose due to remaining infrastructure such as roads.

Past, present, and foreseeable projects that were excluded or scoped out are reflected in Table 18.9.5. Reasons for exclusion included the project being higher than the suitable habitat elevation for moose (above 1,100 masl), does not have or anticipate not to have an impact on moose, has no current activity or traffic, and/or is outside of the Movement Area or CEA boundaries.

##### Potential for Cumulative Effects - Mountain Goats

Two potential residual effects are predicted to have cumulative effects on mountain goat: sensory disturbance and indirect mortality from other historical, existing, and foreseeable future projects (Table 18.9-6). The type of potential cumulative effect is spatial crowding of projects or nibbling loss, that is the gradual disturbance and loss of land and habitat (e.g., noise disturbance to habitat and gradual degradation in quality and use of habitat).

**Table 18.9-4. Potential Cumulative Effects between the Brucejack Gold Mine Project Moose and Other Projects and Activities**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Disruption of Movement	<ul style="list-style-type: none"> <li>• Eskay Creek Mine</li> <li>• Goldwedge Mine</li> <li>• Silback Premier Mine</li> <li>• Sulphurets Project</li> <li>• Granduc Mine</li> </ul>	<ul style="list-style-type: none"> <li>• Brucejack Exploration and Bulk Sample</li> <li>• Forrest Kerr Hydroelectric Power Facility</li> <li>• Long Lake Hydroelectric Power Facility</li> <li>• McLymont Creek Hydroelectric Project</li> <li>• NTL</li> </ul>	<ul style="list-style-type: none"> <li>• Arctos Anthracite Coal Project</li> <li>• Bear River Gravel</li> <li>• Bronson Slope Mine</li> <li>• Galore Creek Mine</li> <li>• Granduc Copper Mine</li> <li>• KSM Project</li> <li>• Kinskuch Hydroelectric Project</li> <li>• Schaft Creek Mine</li> <li>• Treaty Creek Hydroelectric</li> <li>• Volcano Hydroelectric Project</li> </ul>	Spatial crowding of projects results in an additive effect of increased traffic volume, which causes barriers within moose movement routes. The additive effect of the nibbling loss of habitat also reduces connectivity along the landscape.
Direct Mortality	<ul style="list-style-type: none"> <li>• Eskay Creek Mine</li> <li>• Goldwedge Mine</li> <li>• Silback Premier Mine</li> <li>• Sulphurets Project</li> <li>• Granduc Mine</li> </ul>	<ul style="list-style-type: none"> <li>• Brucejack Exploration and Bulk Sample</li> <li>• Forrest Kerr Hydroelectric Power Facility</li> <li>• Long Lake Hydroelectric Project</li> <li>• McLymont Creek Hydroelectric Project</li> <li>• NTL</li> </ul>	<ul style="list-style-type: none"> <li>• Arctos Anthracite Coal Project</li> <li>• Bear River Gravel</li> <li>• Bronson Slope Mine</li> <li>• Galore Creek Mine</li> <li>• Granduc Copper Mine</li> <li>• KSM Project</li> <li>• Kinskuch Hydroelectric Project</li> <li>• Schaft Creek Mine</li> <li>• Treaty Creek Hydroelectric</li> <li>• Volcano Hydroelectric Project</li> </ul>	With the potential for growth; inducing road development, the additive effect of spatial crowding of access roads results in greater exposure to traffic mortality. The growth potential of power projects support development of new projects, which increases traffic on highways and new access roads.
Indirect Mortality	<ul style="list-style-type: none"> <li>• Eskay Creek Mine</li> <li>• Granduc Mine</li> </ul>	<ul style="list-style-type: none"> <li>• Brucejack Exploration and Bulk Sample</li> <li>• Forrest Kerr Hydroelectric Power Facility</li> <li>• Long Lake Hydroelectric Project</li> <li>• McLymont Creek Hydroelectric Project</li> <li>• NTL</li> </ul>	<ul style="list-style-type: none"> <li>• Arctos Anthracite Coal Project</li> <li>• Bronson Slope Mine</li> <li>• Galore Creek Mine</li> <li>• Granduc Copper Mine</li> <li>• KSM Project</li> <li>• Kinskuch Hydroelectric Project</li> <li>• Treaty Creek Hydroelectric</li> <li>• Volcano Hydroelectric Project</li> </ul>	Spatial crowding and growth; potential of access roads results in increased moose hunting opportunities and potential cumulative mortality from harvest.

Past, present, and foreseeable projects that were excluded or scoped out are reflected in Table 18.9.7. Reasons for exclusion included the project being in unsuitable habitat, no interaction with goats, no data available for analyses, and/or being outside of the Movement Area or CEA boundaries.

**Table 18.9-5. Spatially Linked Projects or Activities Scoped Out of the Moose Cumulative Effects Assessment**

Residual Effect	Project/Project Component Excluded	Reason for Exclusion
Disruption of Movement, Direct Mortality, and Indirect Mortality	<ul style="list-style-type: none"> <li>• Johnny Mountain Mine</li> </ul>	Above suitable elevation.
Disruption of Movement, Direct Mortality, and Indirect Mortality	<ul style="list-style-type: none"> <li>• Kitsault Mine (Closed)</li> <li>• Swamp Point Aggregate Mine</li> <li>• Red Chris Mine</li> <li>• Coastal GasLink Pipeline Project</li> <li>• LNG Canada Export Facility</li> <li>• Kitsault Mine</li> <li>• Kutcho Mine</li> <li>• LNG Canada Export Terminal Project</li> <li>• Northern Gateway Pipeline Project</li> <li>• Prince Rupert Gas Transmission Project</li> <li>• Prince Rupert LNG Project</li> <li>• Storie Moly Mine</li> <li>• Turnagain Mine</li> </ul>	Outside of Movement and CEA Areas.

**Table 18.9-6. Potential Cumulative Effects between the Brucejack Gold Mine Project Mountain Goats and Other Projects and Activities**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Sensory Disturbance	<ul style="list-style-type: none"> <li>• Johnny Mountain Mine</li> <li>• Sulphurets</li> <li>• Goldwedge Mine</li> <li>• Silbak Premier Mine</li> <li>• Eskay Creek Mine</li> <li>• Snip Mine</li> </ul>	<ul style="list-style-type: none"> <li>• Brucejack Exploration and Bulk Sample</li> <li>• McLymont Creek Hydroelectric</li> <li>• Forest Kerr Hydroelectric</li> <li>• Long Lake Hydroelectric</li> <li>• Northwest Transmission Line</li> </ul>	<ul style="list-style-type: none"> <li>• Bear River Gravel</li> <li>• Kinskuch Hydroelectric</li> <li>• Volcano Hydroelectric</li> <li>• Treaty Creek Hydroelectric</li> <li>• KSM Project</li> <li>• Galore Creek Mine</li> <li>• Schaft Creek Mine</li> <li>• Bronson Slope</li> <li>• Granduc Copper Mine</li> <li>• Spectra Energy Gas Pipeline</li> </ul>	The spatial crowding of disturbed areas and nibbling loss of habitat due to noise exposure from aircraft and helicopters.
Indirect Mortality	<ul style="list-style-type: none"> <li>• Johnny Mountain Mine</li> <li>• Sulphurets</li> <li>• Goldwedge Mine</li> <li>• Silbak Premier Mine</li> <li>• Eskay Creek Mine</li> <li>• Snip Mine</li> </ul>	<ul style="list-style-type: none"> <li>• McLymont Creek Hydroelectric</li> <li>• Forest Kerr Hydroelectric</li> <li>• Long Lake Hydroelectric</li> <li>• Northwest Transmission Line</li> </ul>	<ul style="list-style-type: none"> <li>• Bear River Gravel</li> <li>• Kinskuch Hydroelectric</li> <li>• Volcano Hydroelectric</li> <li>• Treaty Creek Hydroelectric</li> <li>• KSM Project</li> <li>• Galore Creek Mine</li> <li>• Schaft Creek Mine</li> <li>• Bronson Slope</li> <li>• Granduc Copper Mine</li> </ul>	Spatial crowding and growth-inducing potential of access roads results in increased mountain goat hunting opportunities and potential cumulative mortality from harvest.

**Table 18.9-7. Spatially Linked Projects or Activities Scoped Out of the Mountain Goat Cumulative Effects Assessment**

Residual Effect	Project/Project Component Excluded	Reason for Exclusion
Sensory Disturbance	<ul style="list-style-type: none"> <li>• Johnny Mountain Mine</li> <li>• Sulphurets</li> <li>• Goldwedge Mine</li> <li>• Silbak Premier Mine</li> <li>• Eskay Creek Mine</li> <li>• Snip Mine</li> </ul>	No current aircraft or helicopter activity
Sensory Disturbance	<ul style="list-style-type: none"> <li>• Forest Kerr Hydroelectric</li> <li>• Long Lake Hydroelectric</li> <li>• Bear River Gravel</li> <li>• Granduc Copper Mine</li> </ul>	No noise modeling data available
Indirect Mortality	<ul style="list-style-type: none"> <li>• Johnny Mountain Mine</li> <li>• Snip Mine</li> </ul>	No road access; helicopter access only
Indirect Mortality	<ul style="list-style-type: none"> <li>• Treaty Creek Hydroelectric</li> </ul>	No current road data

Potential for Cumulative Effects - Grizzly Bears

Four potential residual effects are predicted to have cumulative effects on grizzly bears: disruption of movement, direct mortality, indirect mortality, and attractants. Past, existing, and foreseeable projects that were included or scoped out of the CEA are reflected in Table 18.9.8 and 18.9-9, respectively. Reasons for exclusion included no temporal overlap, lack of data, and no relevance to the effect with grizzly bears.

**Table 18.9-8. Potential Cumulative Effects between the Brucejack Gold Mine Project Grizzly Bears and Other Projects and Activities**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Disruption to Movement		<ul style="list-style-type: none"> <li>• Brucejack Exploration and Bulk Sample</li> <li>• McLymont Creek Hydroelectric</li> <li>• Forest Kerr Hydroelectric</li> <li>• Long Lake Hydroelectric</li> <li>• Northwest Transmission Line</li> <li>• fishing</li> <li>• guide outfitting</li> <li>• resident and Aboriginal harvest</li> <li>• mineral and energy resource exploration</li> <li>• recreation and tourism</li> <li>• timber harvesting</li> <li>• traffic and roads</li> </ul>	<ul style="list-style-type: none"> <li>• Kinskuch Hydroelectric</li> <li>• Volcano Hydroelectric</li> <li>• Treaty Creek Hydroelectric</li> <li>• KSM Project</li> <li>• Kitsault Mine</li> <li>• Galore Creek Mine</li> <li>• Schaft Creek Mine</li> <li>• Bronson Slope</li> <li>• <sup>1</sup>Granduc Copper Mine</li> <li>• fishing</li> <li>• guide outfitting</li> <li>• resident and Aboriginal harvest</li> <li>• mineral and energy resource exploration</li> <li>• recreation and tourism</li> <li>• timber harvesting</li> <li>• traffic and roads</li> </ul>	Spatial crowding. Nibbling loss of habitat resulting from the cumulative disturbance across the landscape from all projects or activities.

(continued)

**Table 18.9-8. Potential Cumulative Effects between the Brucejack Gold Mine Project Grizzly Bears and Other Projects and Activities (continued)**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Direct Mortality		<ul style="list-style-type: none"> <li>• Brucejack Exploration and Bulk Sample</li> <li>• McLymont Creek Hydroelectric</li> <li>• Forest Kerr Hydroelectric</li> <li>• Long Lake Hydroelectric</li> <li>• Northwest Transmission Line</li> <li>• fishing</li> <li>• guide outfitting</li> <li>• resident and Aboriginal harvest</li> <li>• mineral and energy resource exploration</li> <li>• recreation and tourism</li> <li>• timber harvesting</li> <li>• traffic and roads</li> </ul>	<ul style="list-style-type: none"> <li>• Bear River Gravel</li> <li>• Kinskuch Hydroelectric</li> <li>• Volcano Hydroelectric</li> <li>• Treaty Creek Hydroelectric</li> <li>• Arctos Anthracite Coal Mine</li> <li>• KSM Project</li> <li>• Kitsault Mine</li> <li>• Galore Creek Mine</li> <li>• Schaft Creek Mine</li> <li>• Bronson Slope</li> <li>• <sup>1</sup>Granduc Copper Mine</li> <li>• fishing</li> <li>• guide outfitting</li> <li>• resident and Aboriginal harvest</li> <li>• mineral and energy resource exploration</li> <li>• recreation and tourism</li> <li>• timber harvesting</li> <li>• traffic and roads</li> </ul>	Spatial crowding of access roads and growth-inducing road development result in cumulative direct mortality across the Movement Area and CEA Area.
Indirect Mortality	<ul style="list-style-type: none"> <li>• Snowfields</li> <li>• Swamp Point Aggregate Mine</li> <li>• Johnny Mountain Mine</li> <li>• Sulphurets</li> <li>• Goldwedge Mine</li> <li>• Silbak Premier Mine</li> <li>• Eskay Creek Mine</li> <li>• Snip Mine</li> <li>• <sup>1</sup>Kitsault Mine</li> <li>• <sup>1</sup>Galore Creek Mine</li> <li>• <sup>1</sup>Granduc Copper Mine</li> </ul>	<ul style="list-style-type: none"> <li>• Brucejack Bulk Sample and Exploration</li> <li>• McLymont Creek Hydroelectric</li> <li>• Forest Kerr Hydroelectric</li> <li>• Long Lake Hydroelectric</li> <li>• Northwest Transmission Line</li> </ul>	<ul style="list-style-type: none"> <li>• Bear River Gravel</li> <li>• Kinskuch Hydroelectric</li> <li>• Volcano Hydroelectric</li> <li>• Treaty Creek Hydroelectric</li> <li>• Arctos Anthracite Coal Mine</li> <li>• KSM Project</li> <li>• <sup>1</sup>Kitsault Mine</li> <li>• Galore Creek Mine</li> <li>• Schaft Creek Mine</li> <li>• Bronson Slope</li> <li>• <sup>1</sup>Granduc Copper Mine</li> </ul>	Spatial crowding and growth-inducing potential of access roads results in increased grizzly bear hunting opportunities.

(continued)

**Table 18.9-8. Potential Cumulative Effects between the Brucejack Gold Mine Project Grizzly Bears and Other Projects and Activities (completed)**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Attractants	<ul style="list-style-type: none"> <li>• Snowfields</li> <li>• Swamp Point Aggregate Mine</li> <li>• Johnny Mountain Mine</li> <li>• Sulphurets</li> <li>• Goldwedge Mine</li> <li>• Silbak Premier Mine</li> <li>• Eskay Creek Mine</li> <li>• Snip Mine</li> <li>• <sup>1</sup>Kitsault Mine</li> <li>• <sup>1</sup>Galore Creek Mine</li> <li>• <sup>1</sup>Granduc Copper Mine</li> </ul>	<ul style="list-style-type: none"> <li>• Brucejack Bulk Sample and Exploration</li> <li>• McLymont Creek Hydroelectric</li> <li>• Forest Kerr Hydroelectric</li> <li>• Northwest Transmission Line</li> <li>• fishing</li> <li>• guide outfitting</li> <li>• resident and Aboriginal harvest</li> <li>• mineral and energy resource exploration</li> <li>• recreation and tourism</li> <li>• timber harvesting</li> <li>• traffic and roads</li> </ul>	<ul style="list-style-type: none"> <li>• Bear River Gravel</li> <li>• Kinskuch Hydroelectric</li> <li>• Volcano Hydroelectric</li> <li>• Treaty Creek Hydroelectric</li> <li>• Arctos Anthracite Coal Mine</li> <li>• KSM Project</li> <li>• <sup>1</sup>Kitsault Mine</li> <li>• <sup>1</sup>Galore Creek Mine</li> <li>• Schaft Creek Mine</li> <li>• Bronson Slope</li> <li>• <sup>1</sup>Granduc Copper Mine</li> <li>• fishing</li> <li>• guide outfitting</li> <li>• resident and Aboriginal harvest</li> <li>• mineral and energy resource exploration</li> <li>• recreation and tourism</li> <li>• timber harvesting</li> <li>• traffic and roads</li> </ul>	Spatial crowding of projects exposes grizzly bear individuals and populations to more attractants with a growth-inducing potential for habituation.

<sup>1</sup>Galore Creek, Granduc Copper and Kitsault Mines were existing mines that closed and are now being considering for re-opening; hence they are considered as both a past project and reasonably foreseeable future project.

**Table 18.9-9. Spatially Linked Projects or Activities Scoped Out of the Grizzly Bear Cumulative Effects Assessment**

Residual Effect	Project/Project Component Excluded	Reason for Exclusion
Disruption to Movement	<ul style="list-style-type: none"> <li>• Northwest Transmission Line, Treaty Creek Hydro Project, Volcano Hydroelectric Project, Granduc Copper Mine, and Kinskuch Hydroelectric Project, fishing, guide outfitting, resident and Aboriginal harvest, mineral and energy resource exploration, recreation and tourism, timber harvesting</li> </ul>	<ul style="list-style-type: none"> <li>• Traffic data were not available.</li> </ul>
Disruption to Movement	<ul style="list-style-type: none"> <li>• Arctos Anthracite Coal Project (rail) and Bear River Gravel Project (ship freighters by water)</li> </ul>	<ul style="list-style-type: none"> <li>• These projects are using alternative means of transportation that will not disrupt grizzly bear movement.</li> </ul>
Indirect Mortality	<ul style="list-style-type: none"> <li>• Goldwedge Mine, Volcano Hydroelectric Project, Bear River Gravel, Kinskuch Hydroelectric Project, Kitsault Mine, Granduc Copper Mine</li> </ul>	<ul style="list-style-type: none"> <li>• No historical road access or proposed development of new access roads.</li> </ul>

(continued)

**Table 18.9-9. Spatially Linked Projects or Activities Scoped Out of the Grizzly Bear Cumulative Effects Assessment (completed)**

Residual Effect	Project/Project Component Excluded	Reason for Exclusion
Indirect Mortality	<ul style="list-style-type: none"> <li>Treaty Creek Hydroelectric Project, Schaft Creek Mine</li> </ul>	<ul style="list-style-type: none"> <li>Proposed access road data were not available.</li> </ul>
Attractants	<ul style="list-style-type: none"> <li>Long Lake Hydroelectric</li> </ul>	<ul style="list-style-type: none"> <li>Construction of the hydroelectric project is complete.</li> </ul>

Potential for Cumulative Effect - American Marten

The residual effect of attractants is predicted to have a cumulative effect on American marten. Past, existing, and foreseeable future projects that were included or scoped out of the CEA are reflected in Tables 18.9-10 and 18.9-11, respectively. Reasons for exclusion included no temporal overlap, lack of data, and no relevance to the effect with American marten.

**Table 18.9-10. Potential Cumulative Effect between the Brucejack Gold Mine Project American Marten and Other Projects and Activities**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Attractants	<ul style="list-style-type: none"> <li>Brucejack Exploration and Bulk Sample</li> <li>Goldwedge Mine</li> <li>Snowfields exploration</li> </ul>	<ul style="list-style-type: none"> <li>Brucejack Bulk Sample and Exploration</li> <li>Northwest Transmission Line,</li> <li>Resident and Aboriginal harvest</li> <li>Mineral and energy resource exploration</li> </ul>	<ul style="list-style-type: none"> <li>Bear River Gravel</li> <li>Treaty Creek Hydroelectric</li> <li>KSM Project, Granduc Copper Mine</li> <li>Resident and Aboriginal harvest</li> <li>Mineral and energy resource exploration</li> </ul>	Spatial crowding of projects exposes American marten to more attractants with a growth-inducing potential for habituation resulting in additive population mortality rates.

**Table 18.9-11. Spatially Linked Projects and Activities Scoped Out of the American Marten Cumulative Effects Assessment**

Residual Effect	Project/Project Component Excluded	Reason for Exclusion
Attractants	<ul style="list-style-type: none"> <li>Long Lake Hydroelectric</li> </ul>	<ul style="list-style-type: none"> <li>Construction of the hydroelectric project is complete so project attractants are not anticipated beyond the capacity of mitigation measures for the limited site infrastructure and personnel present during operations.</li> </ul>

Potential for Cumulative Effect - Western Toads

One potential residual effect is predicted to have cumulative effects on western toads: direct mortality from other historical, existing, and foreseeable future projects (Table 18.9-12). The type of potential cumulative effect is nibbling loss—the gradual disturbance and loss of land and habitat (e.g., clearing of land for new roads into a forested area).

Past, present, and foreseeable projects that were excluded or scoped out are reflected in Table 18.9.13. Reasons for exclusion included lack of data, no impact with western toad (roads), and/or no current activity or traffic.

**Table 18.9-12. Potential Cumulative Effect between the Brucejack Gold Mine Project Western Toad and Other Projects and Activities**

Residual Effect	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Direct Mortality	<ul style="list-style-type: none"> <li>Goldwedge Mine</li> <li>Silbak Premier Mine</li> <li>Sulphurets Project, Granduc Copper Mine<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Brucejack Bulk Sample and Exploration</li> <li>Long Lake, Northwest Transmission Line</li> </ul>	<ul style="list-style-type: none"> <li>KSM Project</li> <li>Treaty Creek, Granduc Copper Mine<sup>1</sup></li> </ul>	Nibbling loss resulting from the cumulative habitat loss of all Projects or activities.

<sup>1</sup> Granduc Copper Mine was an existing mine that closed and now being considering for re-opening; hence considered as both a past project and reasonably foreseeable future project.

**Table 18.9-13. Projects Scoped Out from the Western Toad Cumulative Effects Assessment**

Residual Effect	Project/ Project Component Excluded	Reason for Exclusion
Direct Mortality	<ul style="list-style-type: none"> <li>Goldwedge Mine</li> <li>Silbak Premier Mine</li> <li>Sulphurets Project</li> <li>Granduc Copper Mine (reasonably foreseeable future)</li> <li>Treaty Creek</li> </ul>	<ul style="list-style-type: none"> <li>No road access.</li> <li>Road access through the Granduc Road, no activity and no vehicle traffic.</li> <li>Road access through the existing roads, no activity and no vehicle traffic.</li> <li>Future project will use and upgrade existing roads. No details on Highway traffic volumes.</li> <li>Detailed designs of roads are not currently available.</li> </ul>

### 18.9.2 Analysis of Cumulative Effects

The initial step in the wildlife CEA included determining what projects were spatially or temporally linked for each VC (Tables 18.9-3 and [Appendix 18-C](#), Summary of Potential Temporal Linkages between the Brucejack Gold Mine Project and other Human Actions for Wildlife). This exercise was used to focus the assessment on the interactions that may result in cumulative effects between projects and the residual effects predicted for the Brucejack Gold Mine Project.

The significance of each residual cumulative effect was determined based on effects criteria (see Chapter 6, Assessment Methodology) and existing threshold or land use objectives for each wildlife VC. Theoretically, if the combined effects of all actions within a region do not exceed a certain threshold, the cumulative effects are considered acceptable (not significant). A CEA-adjusted significance rating is generated, and CEA-related adjustments to existing mitigation methods, if required, are suggested.

Thresholds are generally defined as “points where even small changes in environmental conditions will lead to large changes in system state variables” (Hobbs and Suding 2009). Ecological thresholds and/or performance standards are associated with:

- o provincial and federal recovery goals identified in recovery plans and management strategies;
- o landscape unit objectives (i.e., WHA/UWR targets and thresholds); and/or
- o other scientific research.

For some VCs, the CEA may be hindered by a lack of such thresholds or key indicators (FSB 2011). In the absence of defined thresholds, one of the following was done:

- an appropriate threshold or limit of acceptable change or of concern was suggested; or
- if it is acknowledged that there is no established threshold, the residual effect and its significance is reported based on a qualitative assessment.

In most cases, the former was used in this wildlife CEA where an appropriate, defensible threshold exists and the latter is used in all other cases.

Detailed descriptions of the analyses used for the CEA are described in the following receptor VC subcomponent sections (Section 18.9.2.1 to 18.9.2.5).

#### *18.9.2.1 Cumulative Effects on Moose*

At least one past, existing, or reasonably foreseeable future project or land use activity will interact with the three residual effects on moose identified for the Project. Therefore, the CEA is conducted for the following three potential cumulative effects on moose:

- disruption to movement;
- direct mortality; and
- indirect mortality.

Potential cumulative effects primarily result from impacts of roads, transmission lines, and/or increased traffic volume. Corridors (roads and transmission lines) and increased traffic can disrupt moose movement leading to habitat fragmentation. Corridors also provide easy access to areas for hunters (indirect mortality). A larger amount of roads and traffic can also increase vehicle-moose collisions (direct mortality). Past, existing or reasonably foreseeable future projects that use or create roads and transmission lines that may interact with the moose Movement Area or CEA Area are outlined in Table 18.9-4.

#### Cumulative Effects of Disruption of Movement on Moose

The residual effects assessment for moose (Section 18.7.1.1) predicts a low-magnitude residual effect of disruption to movement of moose, which was not significant with mitigation because moose are anticipated to re-occupy habitat and resume movement patterns once the barriers of traffic volume, sensory disturbance, and habitat alterations have been considerably reduced or removed. This residual effect was brought forward into the CEA, which considers all sources of likely residual movement disruptors due to past, existing, and foreseeable future projects and land use activities (Table 18.9-4) that could affect moose within and surrounding the Project (Figure 18.9-2).

Roads and road traffic are the most likely aspects of industrial activity that could cumulatively disrupt movements of moose within the CEA Area. Moose may avoid crossing roads that have high traffic volumes. Thresholds (specific to moose) above which moose in BC will not cross roads are unavailable. Müller and Berthoud (1997) used data from a variety of locations to distinguish three stepped levels of barrier effects to wildlife based on road traffic: 1) roads with less than 1,000 vehicles per day (42 VPH) are permeable to most wildlife species (see grizzly bear for exception)—many individuals successfully cross roads at these traffic rates and casualties are limited; 2) roads with traffic between 4,000 and 10,000 vehicles per day (166 to 416 VPH) impose a strong barrier to movement—noise and movements from the traffic will repel many individuals, and many that cross will get hit; and 3) highways with

traffic levels above 10,000 vehicles per day (over 416 VPH) are impermeable to most species. These traffic rates were used as thresholds to evaluate impacts of cumulative vehicle traffic on moose.

Available traffic volumes from present and future projects within the Project Movement Area and CEA Area were converted to VPH traffic rates (Table 18.9-14). Traffic rates were based on an assumed 24-hour driving day on primary roads because industrial driving can occur throughout a 24-hour period. Background traffic data was estimated (based on 12-hour period) from periodic traffic counts taken in 2005 and 2008 on Highway 37, north of Meziadin Junction and in 2006 north of Dease Lake (BC MOTI 2011a). The average background traffic of 224 vehicles per day was converted to an hourly rate based on an assumed 12-hour driving day, because most driving occurs between 7 a.m. and 7 p.m. Therefore, a background traffic rate of 18.7 VPH was added to all sections of Highway 37 and 37A.

**Table 18.9-14. Traffic Data for Projects within the Brucejack Moose Cumulative Effects Assessment Boundaries**

Project	CEA Time Period	Travel Route	Projected Traffic Rate (VPH based on a 24-h day)	VPH Including Background Traffic (18.7 VPH)
Brucejack Gold Mine Project	Present	Highway 37 and Highway 37A	2.08	20.78
Forest Kerr Hydroelectric Project	Present	Highway 37 and Highway 37A	0.08	18.78
Long Lake Hydroelectric Project	Present	Highway 37 and Highway 37A	0.08	18.78
McLymont Hydroelectric Project	Present	Highway 37	0.08	18.78
Bronson Slope Project	Future	Highway 37 and Highway 37A	0.75	19.45
Galore Creek Project	Future	Highway 37	5.83	24.53
Schaft Creek Mine	Future	Highway 37 and Highway 37A	9.25	27.95
KSM Project	Future	Highway 37 and Highway 37A	Highway 37 = 3 Highway 37A = 4.1	Highway 37 = 21.7 Highway 37A = 22.8
All Project without Brucejack	Present and Future	Highway 37 and Highway 37A	* Highway 37 = 19.1 * Highway 37A = 14.3	* Highway 37 = 37.8 * Highway 37A = 33
All Projects including Brucejack	Present and Future	Highway 37 and Highway 37A	* Highway 37 = 21.2 * Highway 37A = 16.3	* Highway 37 = 39.9 * Highway 37A = 35

\* Where data were available for different project phases on the same route, the maximum VPH was used.

Traffic data were available for seven projects (excluding the Brucejack Gold Mine Project) within the moose CEA Area and Movement Area (Table 18.9-14). Traffic volume data were not available for one present project (Northwest Transmission Line) and four future projects (Granduc Copper Mine, Kinskuch Hydroelectric Project, Treaty Creek Hydro Project, and Volcano Hydroelectric Project). In addition, two projects are not using vehicles and roads as a form of transportation: Arctos Anthracite Coal Project (rail) and Bear River Gravel Project (ship freighters by water).

All of Highway 37 and 37A within the Movement Area and CEA Area were estimated to have hourly vehicular traffic rates below the traffic value of 42 VPH (Table 18.9-14), and roads are therefore expected to be permeable to moose. Traffic along Highway 37 (including existing background traffic) is close to the threshold (approximately 40 VPH). Therefore, a residual cumulative effect of disruption of movement on moose is anticipated.

Moose may also avoid moving through habitat abutting project footprints due to noise or other disturbances (Johnson et al. 2005; Laurian et al. 2008; Stankowich 2008). Movement of moose may also be reduced or impeded where snowbanks and/or earthberms have been created along road edges or within clearings that minimize crossing potential. Earth berms and snowbank heights of 60 to 90 cm along road verges may inhibit road crossing, or the ability of moose to clear the road to get out of the way of oncoming traffic (Peek et al. 1982).

#### Cumulative Effect of Direct Mortality on Moose

The residual effects assessment for moose (Section 18.7.1.2), predicts a low-magnitude effect of direct mortality on moose, which was predicted to be not significant with mitigation. Direct mortality was still considered a potential residual effect to be carried forward into the CEA due to the social, cultural, and economic importance of moose in the region and their sensitivity to moose-vehicle collisions. The potential cumulative effect of increased traffic along Highway 37 within the CEA Area for moose was examined quantitatively, where possible, using available traffic data from the various project.

In most areas of North America, the largest source of direct mortality of moose is moose-vehicle collision. Increased traffic in the moose CEA Area was evaluated for the potential to increase moose-vehicle collisions and thereby direct moose mortality. Moose-vehicle collisions in northern BC are more frequent in winter (December and January), coinciding with times of highest snowfall when moose select roads as travel corridors, as they provide ease of movement (Sielecki 2004, 2010).

There are five LKI segments along Highway 37 that overlap with the CEA Area from Gitwanga (Kitwanga) north to Dease Lake (LKI segments 3710, 3720, 3730, 3740, and 3750). Between 1993 and 2013, there were 305 reported vehicle accidents with moose in the five LKI segments along Highway 37. The majority (60%), of moose collisions occurred in the winter: January (N = 78), February (N = 59), and December (N = 47).

It is estimated that the wildlife collision numbers recorded by the WARS system may only represent 25 to 35% of the actual number of animals killed on roads (Sielecki 2010); therefore, the number of vehicle collisions could be approximately three times greater than reported by the WARS data. The average number of vehicle-moose collisions per year along Highway 37 within the five LKI segments is 5.3. Based on the estimate that the data are under-reported by approximately 70%, the current average number of vehicle-moose collisions along Highway 37 within the CEA Area could in fact be up to 17.7 per year.

The number of moose mortalities due to vehicle strikes may increase with traffic levels or may remain constant. Background traffic rates along Highway 37 were estimated as 18.7 VPH using traffic data (based on a 12-hour period) from periodic traffic counts taken in 2005 and 2008 on Highway 37, north of Meziadin Junction, and in 2006 north of Dease Lake (BC MOTI 2011a). Using the available data from other projects (Table 18.9-14), traffic may double, increasing by approximately 21 VPH along Highway 37, for a total of approximately 40 VPH including existing traffic and 38 VPH without the Brucejack Project (Table 18.9-14). Therefore, if traffic is doubled and a linear relationship is assumed between vehicles per hour and vehicle collisions, then the number of vehicle-moose collisions may double within the CEA Area; therefore, a residual cumulative effect is anticipated.

#### Cumulative Effect of Indirect Mortality on Moose

The residual effects assessment for moose (Section 18.7.1.3) predicts a low-magnitude residual effect of indirect mortality of moose, which was not significant with mitigation. The potential residual effect for indirect mortality is expected to result from increased access and human use of the area. Any new roads built for the Project will be gated and controlled for the life of the Project; at closure, non-essential roads will be deactivated. Increased access may not be completely avoided or mitigated

and is a potential adverse residual effect. This section assesses the overall effect of indirect mortality on moose within the CEA Area and Movement Area for moose (Figure 18.9-2).

Increased mortality rates often occur as an unintended consequence of increased access routes into an area. This well-documented phenomenon is due to mortality as a result of increased access to hunters and increased vulnerability of moose due to reduced cover (Timmerman and Gollat 1982; Girard and Joyal 1984; Eason 1989). Road creation in high-quality moose habitat, particularly when roads are cleared in the winter, could also increase predator access into areas occupied by moose. This could, in turn, increase predator-induced mortality of moose.

Currently, the road density within the moose CEA Area is 0.073 km/km<sup>2</sup> and within the moose Movement Area is 0.08 km/km<sup>2</sup>. The Brucejack Access Road developed in part with the Brucejack Exploration and Bulk Sample project created 72.6 km of road and is equal to the road density of 0.002 km/km<sup>2</sup> in the CEA Area and 0.01 km/km<sup>2</sup> in the Movement Area. The inclusion of roads created by future projects increases this value by 12% for the CEA Area (0.082 km/km<sup>2</sup>), and by 34% for the Movement Area (0.094 km/km<sup>2</sup>). Where these roads are used for mining, they will be access controlled, which will reduce the effect of increased hunting to low levels. Where new roads are not access controlled—such as forestry roads—this effect may increase. Overall, a residual cumulative effect of indirect mortality due to increased hunting access and predator-induced mortality is anticipated.

#### 18.9.2.2 Cumulative Effects on Mountain Goats

Two residual effects on mountain goats identified for the Project will interact with at least one project or activity. The CEA is conducted for the following potential cumulative effects on mountain goats:

- sensory disturbance; and
- indirect mortality.

#### Cumulative Effects of Sensory Disturbance on Mountain Goats

The residual effects assessment for mountain goats (Section 18.7.2.1) predicts a low magnitude residual effect of sensory disturbance for mountain goats that was not significant with mitigation. The effect of sensory disturbance is primarily due to aircraft and helicopter noise within high-quality mountain goat winter and summer habitat. This residual effect was brought forward into the CEA, which considers all sources of likely residual sensory disturbance that could affect mountain goat populations within the mountain goat CEA Area (Figure 18.9-3).

Mountain goats are considered to be more susceptible to disturbances from noise, helicopters, vehicles, and other industrial activity than other ungulate species (Côté 1996; Goldstein et al. 2005; Festa-Bianchet and Côté 2007). As a consequence, helicopters in BC are required to remain greater than 2,000 m from habitats containing goats (Management Plan for the Mountain Goat in British Columbia; BC MOE 2010b).

Mining, hydroelectric, and exploration projects that may disturb goats through helicopter activities were assessed in the CEA Area and Movement Area for mountain goats (Figure 18.9-3). The area of disturbance from applicable projects was calculated using a 2-km buffer. These calculations represent a worst case scenario where all projects go forward and are operating or being constructed simultaneously. As actual flight paths are unknown, this value will overestimate the functional habitat lost as a 2 km buffer was applied to each of the projects (Table 19.3-3).

Within mountain goat habitat (i.e., BAFA BEC zones) in the CEA Area, a total of 20,774 ha (3% of the available BAFA in the CEA Area) is within the 2 km buffer, and is therefore estimated to be disturbed

for mountain goats by industrial helicopter activities without the Brucejack Project. An additional 5,868 ha of functional habitat will be lost due to Sensory Disturbance (Section 18.6.2.3) due to the Brucejack Project. Within the Movement Area, 2,752 ha (6.4% of the available BAFA in the Movement Area) is within the 2-km buffer, and is therefore estimated to be disturbed for mountain goats. This includes the area already considered lost or altered (138 ha) in Section 18.6.2.2 (Habitat Loss and Alteration) and disturbed (8,715 ha) in Section 18.6.2.3 (Sensory Disturbance).

#### Cumulative Effect of Indirect Mortality on Mountain Goats

The residual effects assessment for mountain goats (Section 18.7.2.2) predicts a residual effect of indirect mortality on mountain goats. This effect was of low magnitude and not significant (minor) with mitigation. To determine the potential cumulative effects of indirect mortality on mountain goats, relevant projects potentially contributing to increased access to the area were considered within the CEA Area and Movement Area (Figure 18.9-3).

Increased access into previously inaccessible mountain goat habitat can increase indirect mortality of mountain goats due to increased hunting. Mountain goat populations are sensitive to adult female mortality because of comparatively late age at first reproduction (four to five years old). In addition, mountain goats have low production and low survival of kids (Hamel et al. 2006; Festa-Bianchet and Côté 2007), as a large proportion of mountain goats die within their first or second year of life (Smith 1986). Road creation in high elevation areas, particularly when roads are cleared in the winter, could also increase predator access into areas occupied by goats. This could, in turn, increase predator-induced mortality of young goats.

In order to determine the level of access for hunting via access roads, an assessment of alpine roads was undertaken. Using the biogeoclimatic zones of BC, BAFA was identified as suitable mountain goat habitat. Access to BAFA habitat within the mountain goat CEA boundary could facilitate hunting, thus increasing indirect mortality. There are currently 7.2 km of gravel roads and 1.9 km of forestry roads (total of 9.1 km) accessing BAFA mountain goat habitat within the CEA Area. Two future foreseeable projects, the Brucejack Gold Mine Project and Galore Creek Mine, will add another 2.01 and 1.1 km of roads within the BAFA zone, respectively. Overall, these projects will increase the amount of roads accessing mountain goat habitat by 22%. The majority of this access is located at the mine site area, which can be controlled as long as the mine is operational. Within the mountain goat Movement Area, the only future project with new roads accessing the BAFA zone is the Brucejack Gold Mine Project, with 2 km of mining access roads along with the 1.9 km of forestry roads that already exist.

Very few public or forestry access roads are built into high-elevation mountain goat habitat. If roads are constructed within goat habitat, they will likely be industrial roads, and therefore access would likely be controlled, preventing increased hunting. Despite mitigation, it is anticipated that the potential cumulative effect of indirect mortality may result in a cumulative residual effect to mountain goats.

#### *18.9.2.3 Cumulative Effects on Grizzly Bears*

All four residual effects on grizzly bears identified for the Project will interact with at least one project or activity. The CEA is conducted for the following potential cumulative effects on grizzly bears:

- disruption to movement;
- direct mortality;
- indirect mortality; and
- attractants.

Cumulative Effect of Disruption of Movement on Grizzly Bears

The residual effects assessment for grizzly bear (Section 18.7.3.1) predicts a low-magnitude residual effect of disruption to movement of grizzly bears, which was not significant. With mitigation, grizzly bears are anticipated to re-occupy habitat and resume movement patterns once the barriers of traffic volume, sensory disturbance, and habitat alterations have been considerably reduced or removed. This residual effect was brought forward into the CEA, which considers all sources of likely residual movement disruptors due to relevant projects and human land use activities (Table 18.9-3) that could affect grizzly bears within and surrounding the Project (Figure 18.9-4).

Roads and road traffic are the most likely industrial features that could disrupt movements of grizzly bears. Waller and Servheen (2005) reported that bears will cross roads when traffic volumes are less than 10 VPH, but natural crossing rates can be disrupted when traffic rates exceed this value. Available traffic volumes along Highway 37 from present and future projects within the Movement Area and CEA Area were converted to VPH (Table 18.9-15). Traffic rates were based on an assumed 24-hour driving day on primary roads because industrial driving can occur throughout a 24-hour period. Background traffic data was estimated (based on 12-hour period) from periodic traffic counts taken in 2005 and 2008 on Highway 37, north of Meziadin Junction and in 2006 north of Dease Lake (BC MOTI 2011a).

**Table 18.9-15. Traffic Data for Projects within the Brucejack Gold Mine Project Grizzly Bear CEA Boundaries**

Project	CEA Time Period	Travel Route	Projected Traffic Rate (VPH Based on a 24-h day)	VPH including Background Traffic (18.7 VPH)
Brucejack	Present	Highway 37 and Highway 37A	2.08	20.78
Forest Kerr Hydroelectric Project	Present	Highway 37 and Highway 37A	0.08	18.78
Long Lake Hydroelectric Project	Present	Highway 37 and Highway 37A	0.08	18.78
McLymont Hydroelectric Project	Present	Highway 37	0.08	18.78
Bronson Slope Project	Future	Highway 37 and Highway 37A	0.75	19.45
Galore Creek Mine	Future	Highway 37	5.83	24.53
Kitsault Mine (Future)	Future	Highway 37 and Highway 37A	4.5	23.2
Schaft Creek Mine	Future	Highway 37 and Highway 37A	9.25	27.95
KSM Project	Future	Highway 37	3	21.7
		Highway 37A	4.1	22.8
All Projects without Brucejack	Present and Future	*Highway 37	23.6	42.3
		*Highway 37A	18.8	37.5
All Projects including Brucejack	Present and Future	*Highway 37	25.7	44.4
		*Highway 37A	20.8	39.5

\*Where data were available for different time periods on the same route the maximum VPH was used.

Traffic volume data were also not available for the following projects: Northwest Transmission Line (present), Treaty Creek Hydro Project (future), Volcano Hydroelectric Project (future), Granduc

Copper Mine (future), and Kinskuch Hydroelectric Project (future). In addition, two projects are not using vehicles and roads as a form of transportation: Arctos Anthracite Coal Project (rail) and Bear River Gravel Project (ship freighters by water).

The average background traffic of 224 vehicles per day was converted to an hourly rate based on an assumed 12-hour driving day, because most driving occurs between 7 a.m. and 7 p.m. Therefore, a background traffic rate of 18.7 VPH was added to all sections of Highway 37 and 37A. The background traffic levels on Highway 37 and 37A are almost twice the 10 VPH threshold, potentially already causing a detectable barrier to grizzly bear movement across the highway (Waller and Servheen 2005).

Traffic data were available for eight projects (excluding the Brucejack Gold Mine Project; Table 18.9-15). The addition of traffic from all nine projects along Highway 37 would result in 25.7 VPH, and 20.8 VPH along Highway 37A. The addition of all projects to the baseline brings the total traffic to approximately 44.4 VPH along Highway 37 and 40 VPH along Highway 37A. Traffic on the Brucejack Access Road (3.6 VPH) is expected to remain below the threshold of 10 VPH and are therefore not expected to cause a barrier to grizzly bear movement. Traffic due to the Brucejack Gold Mine Project alone is not enough to cause a disruption of movement for grizzly bears (maximum addition of 3.6 VPH).

The prediction that Highway 37 and 37A are currently acting as a barrier to grizzly bear movement may fragment the population, which increases the chance of local population fluctuations (Lande 1988; Woodroffe and Ginsberg 1998) and reduce gene flow across the barrier (Frankham, Ballou, and Briscoe 2002). The highways may also cause changes to energy budgets of bears that have to travel farther to reach seasonal habitats or that may be excluded from good quality habitat. Although these effects have been identified as already occurring at baseline conditions prior to the addition of predicted traffic from the Project, all nine projects combined will equal 44.4 and 39.5 VPH along Highway 37 and Highway 37A respectively. Without Brucejack, VPH along Highway 37 and Highway 37A will be 42.3 and 37.5 respectively. Although Brucejack will add only marginal value to the VPH, a cumulative residual effect of disruption to movement on grizzly bears is predicted.

#### Cumulative Effect of Direct Mortality on Grizzly Bears

The residual effects assessment for grizzly bear (Section 18.7.3.2) predicts that the residual effect of direct mortality of grizzly bears will be of low magnitude and reversible in the long term, which was determined to be not significant with mitigation. The potential residual effect for direct mortality of grizzly bears predicted for the Project was due to vehicle collisions. This residual effect was brought forward into the CEA, which considers all residual sources of direct mortality due to all relevant projects and human uses of the area that could impact the grizzly bear populations within and surrounding the Project.

Government records (Compulsory Inspection Database) over the past three decades in BC show that, on average, 339 of a total estimated population of 15,900 grizzly bears in BC are killed each year by humans (Rockwell 2012). The vast majority of human-induced mortalities are due to legal harvest (87%). Other causes, in order of decreasing importance, include the destruction of problem bears (7%), illegal kills (3%), vehicular collisions (1.6%), and rail kills (1%). Sources of direct mortality that could be affected by increased human development in the CEA Area and Movement Area include motor vehicle and rail collisions and avalanche control. Hunting (documented and undocumented) is considered in the Indirect Mortality section and destruction of problem bears is considered in the Attractants section below.

Vehicle strikes could increase in some parts of the CEA Area and Movement Area due to increased road densities and traffic from multiple projects. There are five LKI segments along Highway 37 that overlap with the CEA Area from Gitwagak north to Dease Lake (LKI segments 3710, 3720, 3730, 3740, and 3750). Between 1993 and 2013, there were 126 reported vehicle accidents with bears in the five LKI

segments along Highway 37, which are likely an overestimate of grizzly bear collisions as they include reports of black bears (Sielecki 2013). The majority (62%), of bear collisions occurred in September (N = 28), August (N = 25), and July (N = 25).

It is estimated that the wildlife collision numbers recorded by the WARS system may only represent 25 to 35% of the actual number of animals killed on roads (Sielecki 2010); therefore, the number of vehicle collisions could be 65 to 75% higher than reported by the WARS data. The average number of vehicle-bear collisions per year along Highway 37 within the LKI segments is 6.3. Based on the estimate that the data are under-reported by approximately 70%, the number of vehicle-bear collisions along Highway 37 within the CEA Area could in fact be 21 per year.

The number of mortalities due to vehicle strikes may increase with traffic levels (as was predicted for moose) or may remain constant. Grizzly bears are known to avoid highways at even low traffic levels (see previous section, Cumulative Effects of Disruption of Movement on Grizzly Bears), which may act to curb any increases in traffic mortality. For instance, vehicle strikes in areas with higher traffic rates than those expected on Highway 37 account for a relatively small percentage (less than 3%) of human-induced bear mortalities (Rockwell 2012). Rail strikes (due to the coal transport rail line) may also increase with increased use of rail transport in the CEA Area; however, rail strikes also account for a very small percentage of recorded mortalities in the provincial records since bears are hibernating during winter when rail-wildlife issues are common.

The predicted project-related increases in traffic along regional highways are predicted to result in a cumulative residual effect of direct mortality from vehicle collisions for grizzly bears with or without the Brucejack Project as it will add approximately 2 VPH to the overall proposed traffic rate (Table 18.9-15). Some grizzly bears will avoid highways at even low traffic levels (Section 18.6.3.5); however, it is anticipated that grizzly bear mortality will occur as a result of cumulative increases in traffic across the landscape along project access roads and Highways 37 and 37A.

#### Cumulative Effect of Indirect Mortality on Grizzly Bears

The residual effects assessment for grizzly bear (Section 18.7.3.4) predicts that there will be a low magnitude residual effect of indirect mortality to grizzly bears due to increased hunting pressure resulting from increased access. Indirect mortality was determined to be not significant because with mitigation it was anticipated that the residual effect will not impair the local or regional populations. This residual effect was brought forward into the CEA, which considers all residual sources of indirect mortality due to relevant projects and human use of the area (Table 18.9-8), which could affect the grizzly bear populations in the grizzly bear CEA Area (Figure 18.9-4).

Grizzly bears experience increases in legal and illegal/unreported harvest as a consequence of increased road access by hunters (Schallenberger 1980; Zager 1980; McLellan and Mace 1985; Aune and Kasworm 1989). A disproportionate number of human-caused grizzly bear mortalities are known to occur near roads (McLellan and Mace 1985). For example, 63% of bear mortalities occurred within 1 km of a road in the Rocky Mountains (Aune and Kasworm 1989). This well-documented phenomenon is due to increased access to hunters and increased “defence of life,” property kills, and illegal kills (Titus and Beier 1991; Schoen et al. 1994).

Road density (km/km<sup>2</sup>) acts as a proxy for predicting indirect mortality of grizzly bears. All past, existing and foreseeable projects within the grizzly bear CEA Area and Movement Area were considered potential sources of indirect mortality as a result of road development. Proposed access road development information was not available for the Treaty Creek Hydroelectric Project and Schaft Creek Mine projects. No new access roads are proposed for the following foreseeable future projects:

Goldwedge Mine, Volcano Hydroelectric Project, Bear River Gravel, Kinskuch Hydroelectric Project, Kitsault Mine, and the Granduc Copper Mine.

Road density is conservatively predicted to increase by 4.9% in the grizzly bear Movement Area (from 0.14 km/km<sup>2</sup> to 0.15 km/km<sup>2</sup>), and 9.3% in the grizzly bear CEA Area (0.07 km/km<sup>2</sup> to 0.08 km/km<sup>2</sup>). Increases in indirect mortality rates are expected to mirror those increases. The access road developed for with the Brucejack Exploration project, which will be used by the Brucejack Gold Mine Project, has recently created 35 km of new road and rehabilitated 37.6 km of a prior exploration access road. This access road represents 23% of the proposed new roads in both the CEA Area and Movement Area for grizzly bears. Mining access roads will be controlled, which will reduce the effect of increased hunting to low levels. Where new roads are not access controlled—such as forestry roads—this effect may increase. Overall a residual cumulative effect of indirect mortality due to increased hunting access is anticipated.

#### Cumulative Effect of Attractants on Grizzly Bears

The residual effects assessment for grizzly bear predicts a low-magnitude residual effect of attractants for grizzly bears that was determined to be not significant with the implementation of mitigation (Section 18.7.3.5; Section 29.21, Wildlife Management and Monitoring Plan). Grizzly bears are attracted to the odours from human activity such as camps, waste, or carrion along roads. This residual effect is brought forward into the CEA, which considers all residual effects of attractants due to all relevant projects and human use of the area, which could impact the grizzly bear populations within and surrounding the Project (Figure 18.9-8).

The majority of problem bears that are destroyed in North America are bears that were attracted to food such as compost, garbage, roadside mortality, or roadside litter. Food-acclimated bears lose their fear of humans, become a danger, and are often destroyed. From 1989 to 1993, an average of 20 grizzly bears were destroyed per year in BC because of conflict with humans (Rockwell 2012).

It is anticipated that there will be a cumulative residual effect of attractants to grizzly bears due to the recognized risk of camp infrastructure developing problem bears. Developments in the region are remote and overlap grizzly bear habitat so an inevitable encounter with bears often occur. More projects and land-use activities across the landscape result in an increased attractant exposure for grizzly bear individuals and populations. An analysis of the Compulsory Inspection Database over the past three decades in BC shows that, on average, 7% of human-induced mortalities were due to the destruction of problem bears; this accounts for approximately 24 of 339 grizzly bear deaths per year (Rockwell 2012). As projects are added to the CEA Area, the amount of attractants and chances of creating problem bears also increases.

A total of 24 different projects and land-use activities were identified as having the potential to contribute attractants to grizzly bears within the Brucejack Gold Mine Project grizzly bear CEA Area and Movement Area. The assessment did not include past hydroelectric projects and past land-use activities because they will not contribute to attractant concerns for grizzly bears. All of the existing hydroelectric projects were included—except for Long Lake—because these projects are still undergoing construction so will have associated personnel and waste management concerns. All past mines and existing and foreseeable future projects and land-use activities were considered as having the potential to attract grizzly bears to sites. The cumulative effect of attractants on grizzly bears within the CEA Area and Movement Area are anticipated to result in a cumulative residual effect regardless of whether the Brucejack Project is included or not.

#### *18.9.2.4 Cumulative Effects on American Marten*

One residual effect on American marten identified for the Project will interact with at least one project or activity. The CEA is conducted for effect of attractants on American marten.

### Cumulative Effect of Attractants on American Marten

The residual effects assessment for American marten predicts a low-magnitude residual effect of attractants for American marten that was determined to be not significant with the implementation of mitigation (Section 18.7.4.1). American marten are attracted to industrial projects by odours, shelter, food, and prey (Ruggiero et al. 1994). This residual effect is brought forward into the CEA, which considers all residual effects of attractants due to all relevant projects and human use of the area (Table 18.9-10), which could impact American marten within and surrounding the Project (Figure 18.9-5).

Typically when a marten has been exposed to food waste or human shelter it is quite challenging to dissuade them from similar types of attractants. The majority of problem marten are destroyed because of this high level of site fidelity to sources of attractants. The most effective means of mitigating marten attractants is by prevention with a thorough examination of project sites to identify potential sources of attractants such as food wastes and rodent populations, and by blocking entry into infrastructure. The presence of marten attractants within the CEA increases with the number of projects, which will correlate with marten control mortality events.

All past mines, existing mines and land-use activities, and future projects and land-use activities were considered as having potential attractant interactions with marten. Along with the Brucejack Gold Mine Project, the eight projects identified within the CEA and with relevance to marten attractants were: Goldwedge Mine, Snowfields exploration, Northwest Transmission Line, Bear River Gravel, Treaty Creek Hydroelectric, KSM Project, and the proposed Granduc Copper Mine. The two land-use activities were: resident and Aboriginal harvest and mineral and energy resource exploration.

The assessment did not include past land-use activities because they will not contribute residual attractant concerns for marten at this time. The Long Lake hydroelectric project was also not included because construction is complete so it is not anticipated to contribute measurable attractants for marten at this time. The Northwest Transmission line, on the other hand, was included because although it is a hydroelectric project that will likely contribute very little attractant potential to marten when it is operational, it is still within the construction phase of development. It was included within this assessment to account for potential attractants associated with the numerous personnel and camps that are required to build the hydroelectric transmission line.

Due to the presence of multiple projects and land-use activities with the potential to be sources of marten attractants within the CEA Area, a cumulative residual effect was determined for American marten populations regardless whether or not the Brucejack Project is included due to the number of projects. Mitigation measures and awareness of problem marten are anticipated to be consistent for the one existing and four foreseeable future projects within the CEA Area, thereby limiting this effect considerably. Attractants at the historical projects within the CEA Area are anticipated to be very limited.

#### *18.9.2.5 Cumulative Effects on Western Toads*

The cumulative effects on western toad were assessed within the CEA Area identified for western toads (Figure 18.9-6). One potential cumulative effect is predicted to have residual effects on western toads after mitigation: direct mortality.

Potential cumulative effects primarily result from impacts of access roads due to vehicle-collisions (direct mortality). Past, present (existing), or reasonably foreseeable future projects or activities that have or are developing new access roads that may interact with the western toad CEA Area are outlined in Table 18.9-12, with projects excluded from the CEA outlined in Table 18.9-13.

The type of cumulative effect from the remaining projects is the result of a nibbling loss—the gradual disturbance and loss of habitat. Road density, vehicle traffic, and wetland sedimentation all can have cumulative effects on the western toad within the CEA Area boundary.

#### Cumulative Effect of Direct Mortality on Western Toads

The residual effects assessment for Western toad (Section 18.6.10.5) predicts a low-magnitude residual effect of direct mortality for western toad that was not significant with mitigation. This residual effect was due to predicted risks associated with vehicle collisions during movements or migrations or due to vegetation clearing, which could lead to direct mortality due to crushing by heavy machinery or felled trees. This residual effect is brought forward into the CEA, which considers all sources of direct mortality due to relevant projects that could affect western toad populations within and surrounding the Project (Figure 18.9-6).

Migrations of western toads typically occur within a few days, and a large proportion of the local population can cross roads near breeding sites within hours. Therefore, the risk of direct mortality of this species will increase as more roads and cumulative traffic is added to the area. Increases in traffic rates and the creation of new roads due to additional projects within the CEA Area could increase the risk of vehicle collisions for western toads. Road density is expected to increase by 28% in the western toad CEA Area, from a present density of 0.1 km/km<sup>2</sup> to a future density of 0.13 km/km<sup>2</sup>. This value excludes the Alaskan portion of the CEA boundary representing only 2% of the total area. Currently, there is 382.8 km of roads within the CEA boundary and another 107.7 km planned. The majority of this new road construction (68 km) is due to the future KSM Project.

The probability of western toads experiencing mortality by vehicles may increase proportional to the scale of road and traffic increases. It is predicted that the potential cumulative effect of direct mortality may result in a cumulative residual effect to western toads regardless of the Brucejack Project.

### **18.9.3 Mitigation Measures to Address Cumulative Effects**

Mitigation measures to minimize cumulative effects are not necessarily the same as those that are designed to minimize project effects (Hegmann et al. 1999). Mitigating a local effect as much as possible is the best way to reduce project residual effects, which in turn reduces cumulative effects. Measures specifically designed to reduce identified cumulative effects require coordination with regional stakeholders led by the government to implement initiatives that involve mitigation of developments unrelated to the project and proponent (FSB 2011). Such regionally-based mitigation initiatives are beyond the scope of this CEA; however, where possible, measures are suggested for mitigating cumulative effects.

#### *18.9.3.1 Mitigation Measures to Address Cumulative Effects of Sensory Disturbance*

Sensory disturbance was identified as a potential cumulative effect on mountain goats. Pretium as well as other projects contributing to sensory disturbance for mountain goats are expected to follow relevant best management practices and legislative requirements, and to avoid high-quality habitat, UWR, and mineral licks. Projects operating within 500 m of a UWR or occupied goat range are expected to mitigate their development activities seasonally, following the General Wildlife Management Measures under the FRPA (2002b). Helicopters flying over UWR or occupied mountain goat habitat are expected to adhere to setbacks of 2,000 m horizontal distance and 400 m vertical distance, as set out in the Management Plan for Mountain Goats in BC (BC MOE 2010b).

#### *18.9.3.2 Mitigation Measures to Address Cumulative Effects of Disruption of Movement*

Disruption of movement was identified as a potential cumulative effect on moose and grizzly bears.

Pretivism as well as other proponents will try to minimize their traffic volumes and will follow all relevant acts, regulations, and best management practices for the activities that they carry out. It is also expected that proponents will avoid placing infrastructure across or within moose and grizzly bear travel networks where this can be avoided. Where winter use of roads is required and snow clearing activity will occur, it is assumed that gaps in snowbanks will be created at frequent intervals and along corners to allow moose to cross and clear roads. Other proponents are also expected to attempt to design projects such that they meet the objectives of the CIS LRMP and the Nass South SRMP.

#### *18.9.3.3 Mitigation Measures to Address Cumulative Effects of Direct Mortality*

Direct mortality was identified as a potential cumulative effect on moose, grizzly bears, and western toads. It is expected that all other projects will include similar mitigation measures as adopted by the Brucejack Gold Mine Project, primarily setting speed limits and for western toads install toad tunnels where appropriate along project access roads, and will follow all relevant legislation, regulations, and best management practices for the activities that they carry out.

#### *18.9.3.4 Mitigation Measures to Address Cumulative Effects of Indirect Mortality*

Indirect mortality was identified as a potential cumulative effect on moose, mountain goats, grizzly bears, and western toads

It is expected that all other industrial projects will include similar mitigation measures as adopted by the Brucejack Gold Mine Project to minimize the impacts of new road creation on indirect mortality rates for moose, mountain goats, and grizzly bears, and that each project will follow relevant acts, regulations, and best management practices for the activities that they carry out. It is expected that all industry roads would have controlled access, and that only forestry roads would potentially result in increased access.

#### *18.9.3.5 Mitigation Measures to Address Cumulative Effects of Attractants*

Attractants were identified as a potential cumulative effect on grizzly bears and American marten.

It is expected that all other industrial projects within the CEA Area assessed in this report will include similar mitigation measures as adopted by the Project for attractant management to minimize the impacts of increased attraction of grizzly bears and American marten to human-use sites, and will follow all relevant acts, regulations, and best management practices for the activities that they carry out. Reporting of any failures in project attractant management programs, including those of the Project, will be important.

### **18.9.4 Cumulative Residual Effects for Wildlife**

Cumulative residual effects are those effects remaining after the implementation of all mitigation measures and are summarized in Table 18.9-16.

### **18.9.5 Characterizing Cumulative Residual Effects, Significance, Likelihood, and Confidence for Wildlife**

The cumulative residual effects for each receptor VC were characterized by considering the Project's incremental contribution to the cumulative residual effect under the following scenario:

- Future case with the Project: a consideration of all residual effects from past, existing, and future projects and activities on a subcomponent with the Project.

**Table 18.9-16. Summary of Cumulative Residual Effects on Wildlife**

Wildlife VCs	Cumulative Effect	Timing of Cumulative Residual Effect <sup>1</sup>	Description of Cause-Effect <sup>2</sup>	Description of Additional Mitigation (if any)	Description of Cumulative Residual Effect
Moose, Grizzly Bear	Disruption of Movement	Construction and Operation	Increase in barriers (roads, increased traffic volumes)	Participate in regional monitoring programs if applicable.	Spatial crowding of projects results in an additive effect of increased traffic volume, which causes barriers within moose and grizzly bear movement routes. The additive effect of the nibbling loss of habitat also reduces connectivity along the landscape.
Mountain Goat	Sensory Disturbance	Construction and Operation	Aircraft and helicopter noise	Follow current BC Guidelines for air traffic near mountain goat habitat	Nibbling loss due to gradual disturbance to habitat.
Moose, Grizzly Bear, Western Toad	Direct Mortality and Injury	Construction and Operation	Increased traffic results in increased potential for vehicular collisions with wildlife, causing mortality	Other proponents are expected to follow all relevant acts, regulations, and best management practices for the activities that they carry out, and to mitigate and monitor direct mortality, similar to the Project.	The additive effect of spatial crowding of access roads results in greater exposure to traffic mortality. Increased traffic volumes along the highways increase the risk of vehicle collisions.
Moose, Mountain Goat, Grizzly Bear	Indirect Mortality	Construction and Operation	Increased access for hunting (roads, transmission lines)	It is expected that all industry roads would have controlled access, and that only forestry roads would potentially result in increased access.	Spatial crowding and growth-inducing potential of access roads results in increased hunting opportunities and potential cumulative mortality from harvest.
Grizzly Bear, American Marten	Attractants	Construction and Operations	Industrial projects all have an inherent risk for producing attractants - more projects results in increased exposure to attractants for grizzly bear and American marten	Other proponents are expected to include similar mitigation measures as adopted by the Project for attractant management to minimize the impacts of increased attraction of grizzly bears and marten to human-use sites, and will follow all relevant acts, regulations, and best management practices for the activities that they carry out. Tracking of any failures in project attractant management programs, including those of the Project, will be important.	The spatial crowding of projects causes recurring exposure to attractants, which results in an additive effect for habituation with potential subsequent mortality.

<sup>1</sup> Refers to the Project phase or other timeframe during which the effect will be experienced by the intermediate receptor or VC.

<sup>2</sup> "Cause-effect" refers to the relationship between the Project component/physical activity that is causing the change or effect in the condition of the intermediate component, and the actual change or effect that results.

Future cases without the Project were not considered for the Wildlife Cumulative Effects Assessment, as the inclusion or exclusion of the Project when characterizing the cumulative residual effects does not change the conclusions.

#### *18.9.5.1 Cumulative Residual Effects Assessment for Moose*

Past, existing, and reasonably foreseeable future projects are and will continue to contribute to sources of disruption of movement for moose. Table 18.9-4 lists projects and land use activities that could interact with the cumulative residual effects of disruption of movement; Table 18.9-17 characterizes the cumulative residual effects, likelihood, determination of significance, and level of confidence in the assessment of significance for moose.

#### Cumulative Residual Effects of Disruption of Movement on Moose

##### *Cumulative Residual Effect Characterization*

A complete barrier to moose movement is not expected, as traffic rates are estimated to be near the threshold value of 40 VPH along Highway 37 and the Brucejack Project will contribute approximately 2 VPH to the overall traffic rate. The effects along project access roads due to snowbanks and roadside berms can be mitigated. This effect is considered to have a low magnitude, as a partial barrier may still exist. The extent of the effect is regional, and the duration is expected to extend into the far-future, as traffic will be added during the life of the Project and longer. The frequency is sporadic, and the effect is reversible long term, as traffic rates could decrease at closure or through traffic restrictions. The context of the moose population is considered to be high (and resilience low).

##### *Likelihood of Cumulative Residual Effects*

The probability of the effect is medium because it is likely that moose movement will be disrupted, but the effect may not occur.

##### *Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative effect of disruption of movement is assessed as not significant for moose.

##### *Confidence of Cumulative Residual Effects*

The confidence of this effect is medium because while valleys are assumed to be movement corridors, movement data have not been gathered in the field.

#### Residual Effects of Direct Mortality on Moose

##### *Cumulative Residual Effect Characterization*

Direct mortality due to vehicle collisions is assessed as a cumulative residual effect for moose because of traffic during the Project's Construction and Operation phases. The cumulative effect of direct mortality on moose is considered to have a medium magnitude primarily driven by projects other than the Brucejack Project. A magnitude of medium is predicted because the hourly vehicular rates within the Movement Area and CEA Area are expected to approximately double if all projects proceed; however, although the number of vehicle-moose collisions is not expected to increase linearly (i.e., double), the moose mortality rate may be greater than the natural variation of the local population. The extent of the effect is regional, to include highways and roads associated with other projects. The frequency is sporadic and the duration of the effect is expected to be long term because traffic will continue. The effect is reversible long term because of declining traffic volumes at Closure. Due to declining moose populations in the area (e.g., NWA and Highway 37 corridor), the context of the moose population is considered to be high (and resilience low).

**Table 18.9-17. Significance Determination of Cumulative Residual Effects for Moose - Future Case with the Project**

Residual Effects	Cumulative Residual Effects Characterization Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Geographic Extent (local, landscape, regional, beyond regional)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Context (low, neutral, high)			
Disruption of Movement	Low	Far future	Sporadic	Regional	Reversible long-term	Low	High	Medium	Not significant	Medium
Direct Mortality	Medium	Long-term	Sporadic	Regional	Reversible long-term	Low	High	Medium	Not significant	Medium
Indirect Mortality	Low	Far future	Sporadic	Regional	Reversible long-term	Low	High	Low	Not significant	Medium

#### *Likelihood of Cumulative Residual Effects*

The probability of the effect occurring is medium, as it is likely that a collision will occur.

#### *Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative effect of direct mortality on moose is assessed as **not significant**.

#### *Confidence of Cumulative Residual Effects*

The confidence is **medium** because direct mortality from a collision is only likely to occur.

#### Cumulative Residual Effects of Indirect Mortality on Moose

##### *Cumulative Residual Effect Characterization*

The Project roads were evaluated for the potential to increase hunting pressure throughout the CEA Area as a result of increased access created by future projects, increasing the overall density of roads by 12% for the CEA Area (0.082 km/km<sup>2</sup>), and by 34% for the Movement Area (0.094 km/km<sup>2</sup>). This cumulative effect of indirect mortality on moose is considered to have a **low** magnitude, as the combined effect of increased hunting pressure and increased predator access is predicted to affect moose populations to a greater extent than natural variation, but it is assumed that all industry roads will have controlled access, reducing the effect of increased hunting. The extent of the effect is regional. The duration of the effect is expected to extend into the far-future, as the area may be accessible to some degree during the Post-closure phase. The frequency is sporadic, and the effect is reversible long term, due to restricting road access and adaptive mitigation. The context of the moose population is considered to be high (and resilience low), because of the declining moose population in the NWA and Highway 37 corridor and due to high-value habitat along the access roads.

##### *Likelihood of Cumulative Residual Effect*

The probability of the effect occurring is low, due to planned mitigation.

##### *Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative effect of indirect mortality on moose is assessed as **not significant**.

##### *Confidence of Cumulative Residual Effect*

The confidence is also medium due to lack of actual information regarding the number of hunters and associated effects on moose population in the area.

#### *18.9.5.2 Cumulative Residual Effects Assessment for Mountain Goats*

Table 18.9-18 characterizes the cumulative residual effects, likelihood, determination of significance, and level of confidence in the assessment of significance for mountain goats.

#### Cumulative Residual Effects of Sensory Disturbance on Mountain Goats

##### *Cumulative Residual Effect Characterization*

Table 18.9-18 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance of sensory disturbance on goats. The cumulative effect of sensory disturbance may result in 20,621 ha of BAFA (3% of the available BAFA in the CEA Area) that may be disturbed due to industrial helicopter activities. The cumulative effect of sensory disturbance for mountain goat is considered to be low magnitude, and the extent is evaluated as regional.

**Table 18.9-18. Significance Determination of Cumulative Residual Effects for Mountain Goats - Future Case with the Project**

Residual Effects	Cumulative Residual Effects Characterization Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Geographic Extent (local, landscape, regional, beyond regional)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Context (low, neutral, high)			
Sensory Disturbance	Low	Medium-term	Sporadic	Regional	Reversible short-term	Low	Neutral	Medium	Not significant	Medium
Indirect Mortality	Low	Medium-term	Sporadic	Regional	Reversible long-term	Low	Neutral	Low	Not significant	Medium

The duration will be medium for the lives of the projects and sensory disturbance effects may occur sporadically as noise disturbance will come from exposure to temporary aircraft and helicopter flights. The effect is reversible short term, as the effect is directly related to aircraft and helicopter traffic and will stop once the projects are completed. Resiliency is medium and the ecological context for mountain goats is neutral, because they are not listed as a species of conservation concern but are important to Aboriginal traditional harvests and hunting.

*Likelihood of Cumulative Residual Effect*

The likelihood of sensory disturbance occurring is medium, as some disturbance due to aircraft and helicopter noise is likely to occur.

*Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the effect of sensory disturbance is assessed as **not significant** for mountain goats.

*Confidence of Cumulative Residual Effect*

The confidence in the CEA is medium, since it is known that helicopter noise is a disturbance to goats.

Cumulative Residual Effects of Indirect Mortality on Mountain Goats

*Cumulative Residual Effect Characterization*

The foreseeable projects may increase access into mountain goat habitat (i.e., BAFA BEC zone), adding approximately 3 km of roads into goat habitat (Section 18.9.2.2). The Brucejack Gold Mine Project will provide some access to mountain goat habitat increase; however, past and existing projects will not provide uncontrolled access to mountain goat habitat.

There is some uncontrolled access through gravel and forestry roads. The magnitude is rated as low and the extent is evaluated as regional (Table 18.9-18). The duration will be medium and indirect mortality may occur sporadically as industrial access roads will be controlled and no public access granted. The effect is reversible in the long term as roads will be decommissioned. Resiliency is medium and the ecological context of mountain goats is neutral, because they are not listed as a species of conservation concern but are important to Aboriginal traditional harvests and hunting.

*Likelihood of Cumulative Residual Effect*

The likelihood of indirect mortality occurring is low, as access will depend on public access, and it is assumed that other mining project access roads will be controlled.

*Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the effect of indirect mortality is assessed as **not significant** for mountain goats.

*Confidence of Cumulative Residual Effect*

The confidence in the cumulative residual effects assessment is medium.

**18.9.5.3 Cumulative Residual Effects Assessment for Grizzly Bears**

Table 18.9-19 characterizes the cumulative residual effects, likelihood, determination of significance, and level of confidence in the assessment of significance for grizzly bears.

**Table 18.9-19. Significance Determination of Cumulative Residual Effects for Grizzly Bears - Future Case with the Project**

Residual Effects	Cumulative Residual Effects Characterization Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Geographic Extent (local, landscape, regional, beyond regional)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Context (low, neutral, high)			
Disruption of Movement	Medium	Long-term	Sporadic	Regional	Reversible long-term	Neutral	Neutral	High	Not significant	Medium
Direct Mortality	Low	Long-term	Sporadic	Regional	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium
Indirect Mortality	Low	Far future	Sporadic	Regional	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium
Attractants	Low	Long-term	Sporadic	Local	Reversible long-term	Neutral	Neutral	High	Not significant	Medium

### Cumulative Residual Effects of Disruption of Movement on Grizzly Bears

#### *Cumulative Residual Effect Characterization*

Table 18.9-19 characterizes the cumulative residual effects, determination of significance, and level of confidence in the assessment of significance of disruption of movement on grizzly bears. The effect of disruption of movement on grizzly bears is considered to be of medium magnitude mainly driven by projects other than the Brucejack Project because the threshold value of 10 VPH has been exceeded along Highways 37 and 37A—although this threshold level is already exceeded at current existing baseline traffic volumes. The extent of the effect is regional, throughout the CEA Area. The duration of the effect is expected to extend into the far-future. The frequency is expected to be regular, as traffic will likely be present at levels exceeding the threshold during all days comprising the non-hibernation seasons. The effect is predicted to be reversible, as movements would likely resume if traffic rates decreased to below threshold levels. The context of the grizzly bear population is considered to be neutral.

#### *Likelihood of Cumulative Residual Effect*

The probability of the effect occurring is considered high due to the projected cumulative VPH traffic rates that are currently above threshold levels.

#### *Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative residual effect of disruption of movement for grizzly bears is assessed as **not significant**. While this CEA identifies a not significant cumulative effect on movement of grizzly bears as a result of increased cumulative traffic from projects, it is important to note that background traffic rates (based on a 12-hour driving day) along Highway 37 are already potentially disrupting the movement of grizzly bears across this road, as the background traffic rate of 18.7 VPH is above the 10 VPH threshold prior to the Brucejack Gold Mine Project and all other potential projects. Therefore, this CEA identifies this effect as already occurring, but is not significant.

#### *Confidence of Cumulative Residual Effect*

The confidence in the residual effects of disruption of movement on grizzly bears is medium because there is a moderate degree of uncertainty associated with predicting grizzly bear movement patterns. Scientific studies have shown that roads act as barriers to grizzly bear movements (McLellan and Shackleton 1988; Ross 2002; Waller and Servheen 2005) and grizzly bears will encounter traffic along the highways.

### Cumulative Residual Effects of Direct Mortality on Grizzly Bears

#### *Cumulative Residual Effect Characterization*

The residual cumulative effects of direct mortality on grizzly bears will have a low magnitude, as it will likely remain within the natural variation of the local population. Increases in vehicle mortalities are expected to be partly offset by a decreased willingness of bears to cross Highways 37 and 37A with increased traffic (see Disruption of Movement above). The extent of the effect is regional, will extend into the far-future, is sporadic in frequency, and is reversible in the long term.

The context and resiliency of grizzly bears is neutral because grizzly bears are provincially blue-listed and federally identified as Special Concern by COSEWIC (BC CDC 2013); however, the regional population is sustainable (Hamilton, Heard, and Austin 2004; Hamilton 2012). It is not anticipated that cumulative direct mortality effects will affect the viability of the regional grizzly bear population.

*Likelihood of Cumulative Residual Effect*

The probability of direct mortality occurring is medium. In the last 10 years, 126 bears (a combination of grizzly and black bears), were reported in vehicle collisions along the portions of Highway 37 that overlap with the CEA Area from Gitwangak north to Dease Lake (LKI segments 3710, 3720, 3730, 3740, and 3750). However, it is uncertain how many were grizzly rather than black bears, as the data do not identify the species.

*Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative effect of direct mortality on grizzly bears is predicted to be **not significant**.

*Confidence of Cumulative Residual Effect*

The confidence in the residual effects of direct mortality on grizzly bears is medium because although it is clearly understood that traffic poses a risk to grizzly bear survival, it is not known how many bears may in fact attempt to cross the roads, as they may also act as barriers to movement.

Cumulative Residual Effects of Indirect Mortality on Grizzly Bears*Cumulative Residual Effect Characterization*

The cumulative effect of indirect mortality on grizzly bears is considered to have a low magnitude, as the access in the CEA Area, although expected to increase, is still relatively low in terms of road density (below 0.95 km/km<sup>2</sup>) and because access control may eliminate the majority of hunting (both regulated and illegal) along project access roads. The extent of the effect is regional, will extend into the far-future, is sporadic in frequency, and is reversible in the long term when roads are closed and re-vegetated. The context of the population is neutral (and resiliency neutral).

*Likelihood of Cumulative Residual Effect*

The probability of this effect is rated as medium. It is anticipated that harvest mortality of bears may occur as a result of access to high-quality habitat areas from project roads, but it may not occur.

*Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative residual effect of indirect mortality on grizzly bears is assessed as **not significant**. Indirect grizzly bear mortality as a result of the access roads will not viably impair the regional populations with the implementation of access control measures.

*Confidence of Cumulative Residual Effect*

The confidence of indirect mortality for grizzly bears is medium.

Cumulative Residual Effects of Attractants on Grizzly Bears*Cumulative Residual Effect Characterization*

The cumulative effect of attractants on grizzly bears is considered to have a low magnitude, as human presence and production of attractants is expected to increase but remain low due to proper management of wastes. However, the overall role that attractants play in human-induced mortalities (7%) is relatively low compared to factors such as hunting (greater than 87%). The effect of attraction is anticipated to result in a negative effect as bears that become habituated to project-related attractants may have to be destroyed if they become nuisance bears. The extent of the effect is regional (i.e., tied

to other projects in the CEA Area), will extend into the far-future, is sporadic in frequency, and reversible in the long term. The context of the population is neutral (and resiliency neutral)

#### *Likelihood of Cumulative Residual Effect*

The probability of the effect occurring is high because bears are known to be attracted to odours, plastics and solvents, and waste from human activity (McLellan 1990; Blood 2001, 2002; COSEWIC 2002b). It is expected that mitigation will be established at all Project locations to deter most bears from attractants.

#### *Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Brucejack Project, the residual cumulative effect of attractants on grizzly bears was determined to be **not significant**. Mitigation measures are anticipated to resolve the effect of attractants in the long term as grizzly bears have been shown to maintain a high survival rate near human developments when proper mitigation occurs (Ciarniello 1997; H. Davis, Wellwood, and Ciarniello 2002). Attractants present a variable that can negatively influence natural behaviour; however, with proper and consistent mitigation efforts, the effects on grizzly bears will be indistinguishable from background conditions.

#### *Confidence of Cumulative Residual Effect*

The confidence of the effect is medium because the issues surrounding bears and attractants in remote areas are well understood, but may not occur if proper mitigation and management is in place.

#### *18.9.5.4 Cumulative Residual Effects Assessment for American Marten*

Table 18.9-20 characterizes the cumulative residual effects, likelihood, determination of significance, and level of confidence in the assessment of significance for American marten.

#### Cumulative Residual Effects of Attractants on American Marten

##### *Cumulative Residual Effect Characterization*

Marten may be attracted to the camps, waste, and infrastructure of past, existing, and future projects. However, with the application of similar mitigation measures among projects, the magnitude of the cumulative effect of attractants on American marten is determined to be low. The geographic extent of the effect is regional because the effect is directly associated with camp activities and infrastructure within the CEA Area. The duration is long term, the frequency sporadic, and the effect is reversible in the long term because when projects are completed and there are no longer any project-related attractants within the project footprints, the effect will no longer exist (Haroldson, Schwartz, and White 2005). The resiliency of American marten to cumulative attractants is neutral and the ecological context of American marten is neutral.

##### *Likelihood of Cumulative Residual Effect*

The probability of the effect occurring is medium because marten are known to be attracted to the odours, shelter, food, and waste of remote developments (McLellan 1990; Blood 2001, 2002; COSEWIC 2002b). However, it is expected that mitigation will be established at all project locations to deter most marten from attractants, and the effect is therefore anticipated to be minimized.

**Table 18.9-20. Significance Determination of Cumulative Residual Effect for American Marten - Future Case with the Project**

Residual Effects	Cumulative Residual Effects Characterization Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Geographic Extent (local, landscape, regional, beyond regional)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Context (low, neutral, high)			
Attractants	Low	Long-term	Sporadic	Regional	Reversible long-term	Neutral	Neutral	Medium	Not significant	Medium

*Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the cumulative residual effect of attractants on American marten was determined to be **not significant**. It is anticipated that some individuals will modify their behaviour as a result of attractants at different projects; however, mitigation measures are anticipated to minimize the effect of attractants in the long term for most individuals.

*Confidence of Cumulative Residual Effect*

The confidence of the effect is medium because the issues surrounding marten and attractants in remote areas are well understood, but may not occur if proper mitigation and management is in place.

*18.9.5.5 Cumulative Residual Effects Assessment for Western Toads*

Table 18.9-21 characterizes the cumulative residual effects, likelihood, determination of significance, and level of confidence in the assessment of significance for western toads.

Cumulative Residual Effects of Direct Mortality on Western Toads*Cumulative Residual Effect Characterization*

The cumulative effect of direct mortality on western toads is considered to be of low magnitude, as the likelihood that direct mortality due to vehicle collisions and vegetation clearing could affect population sizes beyond levels of natural variation is considered limited with mitigation. Road density is expected to increase by 28% in the western toad CEA Area, from a present density of 0.1 km/km<sup>2</sup> to a future density of 0.13 km/km<sup>2</sup> (Section 18.9.2.5). The extent of the effect is regional, and the duration is long term as mortality will continue until projects close and roads are no longer used. The frequency is sporadic, and the effect is reversible in the long term. The context of the population is high (and resilience is low), as western toads are listed on Schedule 1 of SARA (2002c), although the local population in BC is considered healthy (blue-listed in the province).

*Likelihood of Cumulative Residual Effect*

The likelihood of direct mortality occurring is medium, as some mortality is likely to occur, but may not with proper mitigation.

*Significance of Cumulative Residual Effect*

Considering the future-case scenario with the Project, the effect of direct mortality is assessed as **not significant** for western toads.

*Confidence of Cumulative Residual Effect*

The confidence in the cumulative effects of direct mortality on western toads is medium.

**18.10 EFFECTS ASSESSMENT CONCLUSIONS FOR WILDLIFE**

The scoping process identified 10 wildlife receptor VCs: moose, mountain goat, grizzly bear, American marten, hoary marmots, bats, raptors, migratory waterbirds, migratory land birds, and western toads. Potential effects on wildlife include: 1) habitat loss and alteration; 2) sensory disturbance, 3) disruption of movement; 4) direct mortality; 5) indirect mortality; 6) attractants; and 7) chemical hazards. Despite application of mitigation measures, residual effects are predicted for five receptor VCs: moose, mountain goat, grizzly bear, American marten, and western toad. Low-magnitude effects are predicted for all of the individual effects on each subcomponent. Medium-magnitude effects are predicted for the overall additive effect (i.e., all residual effects acting synergistically on the VC) for moose and grizzly bears. However, through the implementation of mitigation and monitoring, no residual effects are assessed as significant associated with the Project.

**Table 18.9-21. Significance Determination of Cumulative Residual Effect for Western Toads - Future Case with the Project**

	Cumulative Residual Effects Characterization Criteria							Likelihood (low, medium, high)	Significance of Adverse Residual Effects (not significant, significant)	Confidence (low, medium, high)
	Magnitude (low, moderate, high)	Duration (short-term, medium-term, long-term, far future)	Frequency (once, sporadic, regular, continuous)	Geographic Extent (local, landscape, regional, beyond regional)	Reversibility (reversible short-term, reversible long-term, irreversible)	Resiliency (low, neutral, high)	Context (low, neutral, high)			
Residual Effects										
Direct Mortality and Injury	Low	Long-term	Sporadic	Regional	Reversible long-term	Low	High	Medium	Not significant	Medium

An assessment of cumulative effects was also conducted, which evaluated the effects of the Brucejack Gold Mine Project in addition to other mining projects, hydroelectric projects, forestry, and other land use activities in the area. A scoping process identified which wildlife VCs, additional projects, and potential effects were to be evaluated (Section 18.9). The five wildlife VCs with residual effects were evaluated (moose, mountain goat, grizzly bear, American marten, and western toad). The Brucejack Project will be a small contributor to the overall cumulative effects, thus no significant residual effects were predicted for any of the VCs (Table 18.10-1).

**Table 18.10-1. Summary of Project and Cumulative Residual Effects, Mitigation, and Significance for Wildlife**

Residual Effects	Project Phase(s)	Mitigation Measures	Significance of Residual Effects	
			Project	Cumulative
<b>Moose</b>				
Disruption of Movement	Construction and Operation	Traffic and road management, snow clearing protocol (gaps in snowbanks), and avoid building infrastructure near moose travel networks.	Not significant	Not significant
Direct Mortality and Injury	Construction and Operation	Traffic and road management.	Not significant	Not significant
Indirect Mortality	Construction, Operation and Closure/Post-Closure	Minimize development of new roads combined with controlled access on existing project roads.	Not significant	Not significant
<b>Mountain Goat</b>				
Sensory Disturbance	Construction and Operation	Apply the current BC Guidelines for air traffic near mountain goat habitat.	Not significant	Not significant
Indirect Mortality	Construction, Operation and Closure/Post-Closure	Limit road access to employees with no public access.	Not significant	Not significant
<b>Grizzly Bear</b>				
Disruption of Movement	Construction and Operation	Low speed limits, employee education and shuttling staff to the site to limit traffic.	Not significant	Not significant
Direct Mortality and Injury	Construction and Operation	Yielding to wildlife, signage along roads, and vegetation management at identified wildlife crossings.	Not significant	Not significant
Indirect Mortality	Construction, Operation and Closure/Post-Closure	Restricting road access to deter trespassers.	Not significant	Not significant
Attractants	Construction and Operation	Waste management practices, and planting less attractive roadside vegetation.	Not significant	Not significant
<b>American Marten</b>				
Attractants	Construction and Operation	Waste Management practices and deterring entry into infrastructure.	Not significant	Not significant
<b>Western Toad</b>				
Direct Mortality and Injury	Construction and Operation	Amphibian tunnels and culverts, monitoring, and management plans and adaptive management.	Not significant	Not significant

Several species or groups were evaluated in the scoping section and excluded from the assessment as potential VCs because other species with similar habitat requirements were selected as a VC and could act as a proxy for other species. Fisher and wolverine were considered to have similar responses as

American marten and grizzly bear assessments. Hence, potential residual effects on fisher and wolverine due to the Project are also considered not significant. Lynx, fox, coyote, and weasel were considered to have the same responses as the American marten assessment; therefore, potential residual effects on these four species are also considered not significant. Wolf was considered under the moose assessment, as moose are a primary prey source for wolf. The potential residual effects on wolf from the Project are therefore also considered not significant (Table 18.10-1).

Northern goshawk, short-eared owl, trumpeter swan, grouse, ptarmigan, olive-sided flycatcher, rusty black bird, and common nighthawk were not considered separate VCs for this assessment because any potential effects on these species would be addressed in the raptor, waterbird, and landbird assessments. After implementation of mitigation, no residual effects were predicted for all avian species. Hence, no residual effects were predicted for the five SARA-listed bird species (short-eared owl, northern goshawk, olive-sided flycatcher, rusty blackbird, and common nighthawk), or on trumpeter swan, grouse, and ptarmigan.

Frog species, such as wood frogs and Columbia spotted frogs were excluded from the assessment because any potential effects on the species are addressed in the assessment of alteration to wetland extent in the wetlands section (Chapter 17, Assessment of Potential Wetlands Effects). The magnitude of the effects of the Project on wetlands is expected to be low, thus the interactions were not considered important. Therefore, potential residual effects on wood frogs and Columbia spotted frogs are also considered not significant.

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