Appendix 22-A

2012 Archaeology Baseline Report

ERM

Pretium Resources Inc.

BRUCEJACK GOLD MINE PROJECT
2012 Archaeology Baseline Report

PRETIVM

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BRUCEJACK GOLD MINE PROJECT
2012 ARCHAEOLOGY BASELINE REPORT

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Prepared by:

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Executive Summary

Executive Summary

This cumulative baseline report summarizes the results of archaeological assessments undertaken by Rescan Environmental Services Ltd. in 2010, 2011, and 2012 for Pretium Resources Inc.'s Brucejack Gold Mine Project (the Project). The Brucejack property is situated within the Sulphurets District in the Iskut River region, approximately 20 kilometres northwest of Bowser Lake or 65 kilometres north-northwest of the town of Stewart, British Columbia.

Archaeological baseline studies for the Project were conducted under *HCA* Heritage Inspection Permits 2010-0255 and 2011-0245 issued for the Project (Walker and McKnight 2011, Jollymore and Walker 2013). The objectives of these studies were consistent with those outlined in the permit applications: 1) to identify and evaluate any archaeological sites within and adjacent to the proposed development's footprint; 2) to identify and assess possible impacts from the proposed developments on any identified archaeological sites; 3) to provide recommendations regarding the need for and appropriate scope of further archaeological studies before initiating any proposed developments; and 4) to recommend viable alternatives for managing adverse impacts, if any are identified. The objectives of this study were to:

- provide a review of previous archaeological work that may provide a regional context;
- provide a summary of the work conducted during the AIAs carried out for the Project; and
- identify any archaeological sites within or adjacent to the Project footprint.

The study considered a Regional Study Area (RSA) and a Local Study Area (LSA). The RSA for the study was based on the permit area delineated for *HCA* Heritage Inspection Permit 2011-0245. The LSA focussed on the Project footprint assessed including an access road, the mine site and associated infrastructure, and a transmission lines routes.

Nine archaeological sites were identified within the Archaeological Regional Study Area. A total of 2,358 shovel tests were conducted in 99 locations throughout the Archaeological Local Study Area and two previously unknown prehistoric archaeological sites (HcTn-1 and HbTm-1) were identified. HbTm-1 is protected by the *HCA* and HcTn-1 has been assigned Legacy Status by the Archaeology Branch as the site has been mitigated through surface collection and is no longer protected by the *HCA*. A Legacy aircraft wreck site associated with a movie production (HbTm-2) was also documented; similarly, this site is not protected by the *HCA*. The area has been subject to extensive historic mineral exploration and a number of historic features were observed during field investigations but are not protected by the *HCA*.

The Project is located in an area that has ice patches, glaciers, and recently deglaciated areas. As such, the potential for archaeological materials to occur in these areas was considered during this study. A glacial specialist reviewed the Local Study Area that is in proximity to ice patches, glaciers, and recently deglaciated areas to determine the potential for archaeological materials to be present; it was determined that the potential for sites to be present on an active glacier is low, though there is a likelihood that sites could be present at smaller stagnant ice features. Field investigations were undertaken to confirm this assessment. No archaeological materials were found in association with ice patches, glaciers, or recently deglaciated areas.

The archaeological assessments focussed on the Local Study Area. Any revisions to the currently proposed Project footprint should be reviewed by a qualified professional archaeologist. Even the most thorough study may not identify all archaeological resources that may be present; an Archaeological Chance Find Procedure should be implemented prior to the commencement of ground altering activities. All Project staff should be familiarized with the procedure and the protocols for managing the known archaeological sites and any chance finds that may occur during construction. This report is intended for public distribution and use by Pretium Resources Inc. during the environmental assessment for the Project. As per Archaeology Branch policy, descriptions of archaeological sites and their locations cannot be shared or redistributed to the public. As such, maps showing archaeological site locations are not included in this report. This information, along with recommendations on the need for further archaeological studies and the management of adverse impacts, will be provided to the proponent, the Archaeology Branch, and identified First Nations in the Archaeological Impact Assessment (AIA) Permit Reports. This baseline report is not an interim or final AIA permit report. This study was not designed to address issues of traditional Aboriginal use and does not constitute a traditional use study. This report was written without prejudice to issues of Aboriginal rights and/or title.

Acknowledgements

Engineers and Scientists

Acknowledgements

This report was produced for Pretium Resources Inc. by Rescan Environmental Services Ltd. It was written by Sean McKnight (B.A., RPCA), Daniel Walker (M.A., RPCA), and Kay Jollymore (B.A.), and reviewed by Lisa Seip (M.A., RPCA, CAHP). Andrew Duthie (M.Sc.) and Greg Norton (M.Sc.) were the project managers and Nicole Bishop (B.Sc.) the project coordinator. Graphics production was coordinated by Francine Alford (B.F.A.), GIS production was coordinated by Pieter van Leuzen (M.Sc.) and report production was coordinated by Robert Tarbuck (BTECH). Fieldwork was conducted in 2010 by Daniel Walker and Sean McKnight with assistance from Marc Jenkins and Mike Weget of the Skii km Lax Ha, in 2011 by Daniel Walker and Jordan Ardanaz with assistance from Bryan Farbridge, Paulo Tamasone, Joseph Cristobal, Shannon Cummings, and Laura Ramsden of Pretium Resources Inc., and in 2012 by Daniel Walker and Kay Jollymore (née Farquharson) with assistance from Cody George, Scott Muldon of the Gitxsan.

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2012 ARCHAEOLOGY BASELINE REPORT

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Glossary and Abbreviations

Engineers and Scientists

Glossary and Abbreviations

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

Archaeological Impact Assessment (AIA)	An assessment carried out under a *Heritage Conservation Act* Heritage Inspection Permit to determine the impact of a development on archaeological sites.
Heritage Inspection Permit	Heritage Inspection and Heritage Investigation Permits are issued under Section 14 of the *HCA* subsequent to Archaeology Branch review and authorization.
Archaeology Branch	The Archaeology Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations that administers the *HCA*.
BC	British Columbia.
Blaze	Blazed trees were commonly used to identify a trail and were made by removing a section of bark from a tree with an axe.
BP	Before Present.
ca.	Circa.
CE	Common Era.
Culturally Modified Tree (CMT)	A CMT is a tree that has been altered by Aboriginal people. For the purpose of this report, only CMTs predating 1846 alterations are considered.
DBS	Depth below surface. A means of describing shovel test/soil stratigraphy relative to the surface of a given area.
***Heritage Conservation Act* (*HCA*)**	The provincial law that authorizes and mandates British Columbia to manage heritage resources.
In situ	In its original position/location.
Lithics	The material created during stone tool manufacturing.
LSA	Archaeological Local Study Area.
masl	Metres above sea level.
Mount Edziza	A volcano in northwestern BC that is a source of obsidian (a lithic material used in stone tool manufacture).
Pretivm	Pretium Resources Inc.; the proponent for the Brucejack Gold Mine Project.
Project	Pretium Resources Inc.'s Brucejack Gold Mine Project.
Proglacial Lake	A proglacial lake is a lake formed either by the damming action of a moraine or ice dam during the retreat of a melting glacier, or by meltwater trapped against an ice sheet due to isostatic depression of the crust around the ice.

RAAD	Remote Access to Archaeological Data; a web-based application, maintained by the Province of British Columbia, that enables authorized users to access data housed in the British Columbia Archaeological Site Inventory.
Regional District Kitimat-Stikine	The local government of a 100,000 km^2 area in northwestern British Columbia including the Project area. Member municipalities are Kitimat, Terrace, Stewart, Hazelton, and New Hazelton.
Rescan	Rescan Environmental Services Ltd.
RSA	Archaeological Regional Study Area.
tpd	Tonne per day.
XRF	X-ray Fluorescence Spectrometry. A non-destructive method used to determine the elemental composition of natural and man-made materials, such as obsidian, to aid in determining its source.

1. Introduction

1. Introduction

This cumulative baseline report summarizes the results of archaeological assessments undertaken by Rescan Environmental Services Ltd. in 2010, 2011, and 2012 for Pretium Resources Inc.'s (Pretivm's) proposed Brucejack Gold Mine Project (the Project) under *Heritage Conservation Act* Heritage Inspection Permits 2010-0255 and 2011-0245 (Walker and McKnight 2011, Jollymore and Walker 2013).

An archaeological Regional Study Area (RSA) and an Local Study Area (LSA) were considered during this study. The RSA was based on the permit area delineated for *HCA* Heritage Inspection Permit 2011-0245. It measured 57 km north-south by 60 km east-west from Highway 37 to Sulphurets Creek, and included portions of the Bowser River, Sulphurets Creek, and Treaty Creek watersheds. The LSA included a 1 km buffer on either side of the proposed Project footprint which included an the access road from Highway 37 to the current Brucejack exploration camp, proposed Project infrastructure related to the development of the Brucejack deposit and a transmission line route (south option), which would bring power from the Long Lake Hydroelectric Project being built near the Premier Mine. Field assessments were conducted within the LSA with a focus on the proposed Project footprint.

This report is intended for public distribution by Pretivm during the environmental assessment application. As per Archaeology Branch policy, descriptions of archaeological sites and their locations cannot be shared or redistributed to the public. As such, no maps showing archaeological site locations are included in this report. This information, along with recommendations on the need for further archaeological studies and the management of adverse impacts, will be provided to the proponent, the Archaeology Branch, and identified First Nations in the AIA Permit Reports. Site specific information may be available by the Archaeology Branch upon request.

2. Project Description

2. Project Description

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

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

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

The general area of the Brucejack Property has been the target of mineral exploration since the 1960s. In the 1980s Newhawk Gold Mines Ltd. conducted advanced exploration activities at the current site of the proposed Brucejack mine site that included 5 km of underground development, construction of an access road along the Bowser River and Knipple Glacier, and resulted in the deposition of 60,000 m^3 of waste rock within Brucejack Lake.

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

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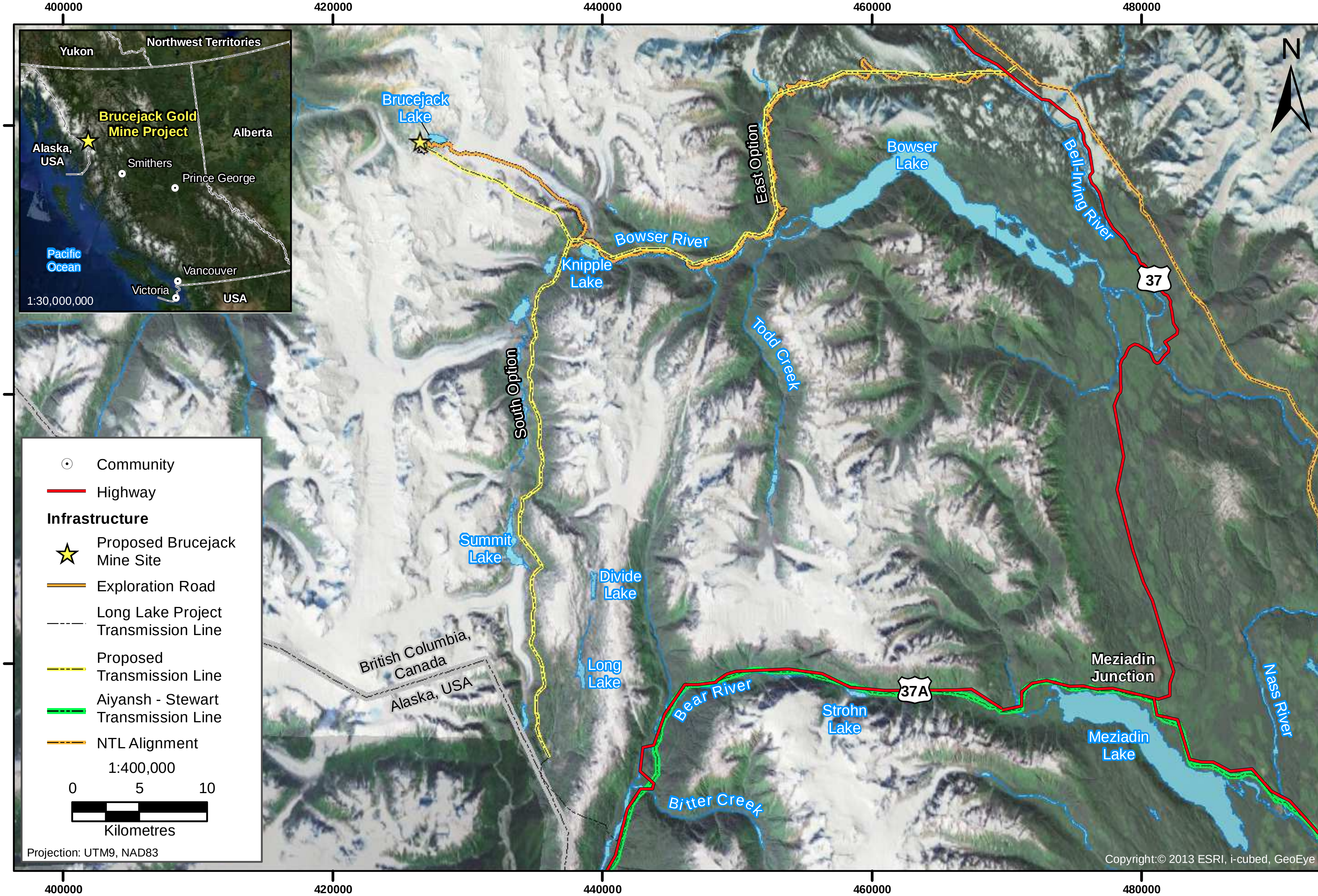

Figure 2-1

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Brucejack Gold Mine Project Overview

Figure 2-1

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3. Background Information

3. Background Information

3.1 APPLICABLE LEGISLATION (FEDERAL AND PROVINCIAL)

The primary legislation protecting archaeological resources in British Columbia is the provincial *Heritage Conservation Act* (1996). In British Columbia, the *HCA* automatically protects all archaeological sites predating 1846 CE on Crown and private land. Sites such as burials and Aboriginal rock art sites are protected regardless of age. The Archaeology Branch (Ministry of Forests, Lands and Natural Resource Operations) is responsible for administering the *HCA* by issuing permits for site inspection and alterations, and maintaining a database of known archaeological sites.

Additional legislation that contain sections pertaining to archaeology, or heritage resources generally, include the *Canadian Environmental Assessment Act* (CEAA) and the *Local Government Act* (LGA). If applicable to the Project, the CEAA includes a requirement to consider the effect of a project on physical and cultural heritage. Additionally, any sites listed on a heritage registry established under the *Local Government Act* (LGA) could also be subject to protection or other conditions; the Regional District of Kitimat-Stikine's (RDKS) maintains a heritage registry for this region of the province.

3.2 LITERATURE REVIEW

A review of published information for the region surrounding the Project was conducted prior to fieldwork. This included a review of environmental, ethnographic, historic, and archaeological literature, and included a search of the British Columbia Archaeological Site Inventory using the Remote Access to Archaeological Data (RAAD) application. First Nations and Nisg̱a'a Nation land use and knowledge reports were reviewed when available, and the Nisg̱a'a Final Agreement was reviewed. When practicable, environmental data from a variety of baseline studies underway for the Project were reviewed. Much of the information obtained from the literature review has been incorporated into the description of the natural and heritage settings for the Study Area (Chapter 5).

3.3 FIRST NATIONS AND NISG̱A'A NATION COMMUNICATIONS

The Archaeology Branch forwarded the permit application for *HCA* Heritage Inspection Permit 2010-0255 to a number of Aboriginal groups/organizations for review and comment on June 7, 2010. The permit application was sent to the Gitanyow Hereditary Chiefs' Office, Gitxsan Treaty Office, Skii km Lax Ha, Tahltan Central Council, Wilp Spookw/Guuhadakw/Yagosip, and Nisg̱a'a Lisims Government and was issued by the Archaeology Branch on July 9, 2010.

Similarly, the Archaeology Branch forwarded the permit application for *HCA* Heritage Inspection Permit 2011-0245 to a number of Aboriginal groups/organizations for review and comment on June 25, 2011. The permit application was sent to the Gitanyow Hereditary Chiefs' Office/Band Council, Gitxsan Treaty Office, Tahltan Central Council, Wilp Spookw/Guuhadakw/Yagosip, Wilp GwininNitxw, Skii km Lax Ha, and Nisg̱a'a Lisims Government and issued by the Archaeology Branch on July 28, 2011.

Copies of the final permit reports for both permits were sent to the groups/organizations noted. Individuals who participated in fieldwork are listed in the Acknowledgements section of this report.

4. Objectives

4. Objectives

Archaeological baseline studies for the Project were conducted under *HCA* Heritage Inspection Permits 2010-0255 and 2011-0245 issued for the Project (Walker and McKnight 2011, Jollymore and Walker 2013). The objectives of these studies were consistent with those outlined in the permit applications; the objectives were to:

- identify and evaluate any archaeological sites within and adjacent to the proposed development's footprint;
- identify and assess possible impacts from the proposed developments on any identified archaeological sites;
- provide recommendations regarding the need for and appropriate scope of further archaeological studies before initiating any proposed developments; and
- recommend viable alternatives for managing adverse impacts, if any are identified.

The objectives of this baseline report are to:

- provide a review of previous archaeological work that may provide a regional context;
- provide a summary of the work conducted during the AIAs carried out for the Project; and
- identify any archaeological sites within or adjacent to the Project footprint.

5. Study Area

Engineers and Scientists

5. Study Area

The RSA for the archaeology baseline is the permit area delineated for *HCA* Heritage Inspection Permit 2011-0245. It measures approximately 57 km north-south by 60 km east-west, extending west from Highway 37 to Sulphurets Creek, and includes portions of the Bowser River, Sulphurets Creek, and Treaty Creek watersheds (Figure 5-1). The LSA is focussed on the proposed Project development footprint (including the mine site and associated infrastructure, access road alignment, and transmission line alignment) (Figure 5-2). Data gathered during the literature review conducted for the Project is summarized below.

5.1 NATURAL SETTING

This section describes the present-day environmental setting of the RSA and provides a summary of the region's paleoenvironmental history. The RSA is classified as part of the Nass Ranges Ecoregion within the Coast and Mountains Ecoprovince of northwestern British Columbia (Demarchi 1996). The Brucejack Mine Site and access road are located in the Nass Ranges Ecoregion, a mountainous transitional area between coast and interior climatic regimes, and the southern portion of the transmission line is located in the Boundary Ranges Ecoregion, a rugged, largely ice-capped, mountain range that rises from the coast of southeastern Alaska. Elevations range from 360 m above sea level (masl) at the shores of Bowser Lake to greater than 1,500 masl at the Brucejack Mine Site.

5.1.1 Paleoenvironmental Conditions

During the late Wisconsinan Glaciation glacial maximum (20,000 - 16,000 BP) the region was completely covered by the Cordilleran ice sheet (Fladmark 2001). Ice-free land ("nunataks") may have protruded through the ice sheet. However, these nunataks would not have supported much flora or fauna. During the early Holocene epoch the warmer climate caused the Cordilleran ice sheet to recede. Information from the lower Skeena Valley indicates that rapid glacial recession began about 15,000 years ago. This resulted in the redeposition of material collected in the glaciers as moraines and outwash. By 9,500 BP the extent of the remaining glaciers in the region was likely similar to present (Fladmark 2001).

Bowser Lake was created during the Holocene as the Wisconsinan ice retreated westward from the Bowser River Valley. Alluvial deposits accumulated at the mouth of Surveyors Creek and along the Bell-Irving River and constricted the outflow of Bowser Lake at its eastern end. In addition, thick layers of sediments were deposited in the lake as a result of jökulhlaups (glacier outburst floods) from upstream and the Bowser River floodplain advanced into Bowser Lake during the Holocene. Holocene lake levels appear to have been higher than current levels as sediments were deposited at its western end and the alluvial fan of Surveyors Creek at its eastern end grew and fill accumulated in the Bell-Irving Valley. These alluvial deposits at the lake's eastern end were ultimately incised by the Bowser River, leaving a series of terraces and led to the eventual lowering of the lake level (Gilbert, Desloges, and Clague 1997).

Following the initial glacial recession, pioneer plant species well adapted to the cool, dry environment thrived (e.g., lodgepole pine, shrubs, willow; Clague 1989). During the Hypsithermal Interval (7,000 to 5,000 BP), temperatures increased until they were approximately 2 - 3°C warmer than today. This increase in temperature caused further glacial retreat and allowed subalpine parklands to expand to higher elevations (Fladmark 1985). From 8,200 to 3,500 BP the diversity of flora was increasing with Sitka spruce, mountain and western hemlock, and alder becoming established in new areas (Heusser 1960). A caribou antler dated to approximately 3,760 BP located in a snow patch near the Iskut-Ningunsaw confluence suggests that the winter range of caribou had extended further west during

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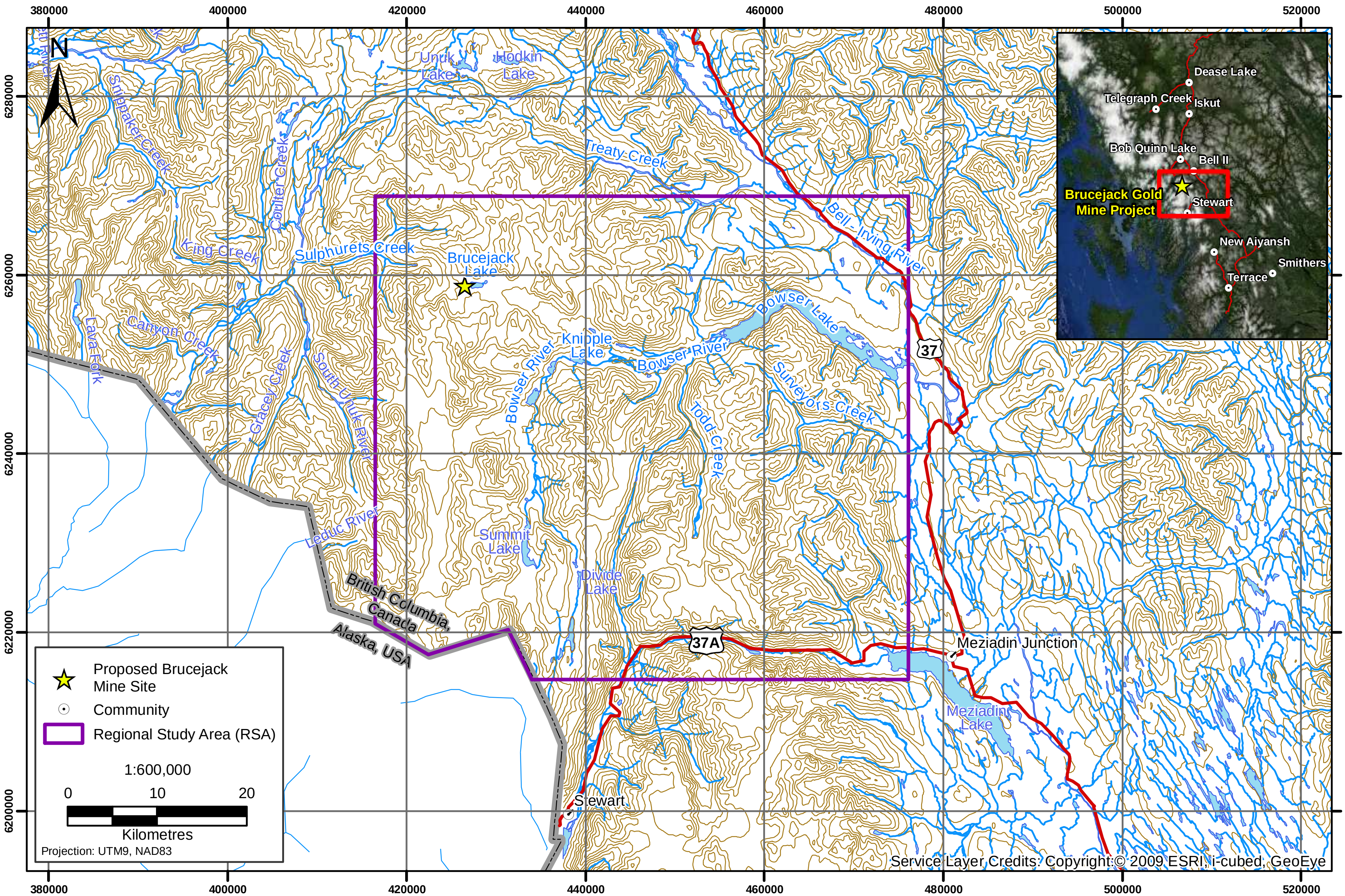

Figure 5-1

Figure 5-1

Brucejack Gold Mine Project Archaeological Regional Study Area (RSA)

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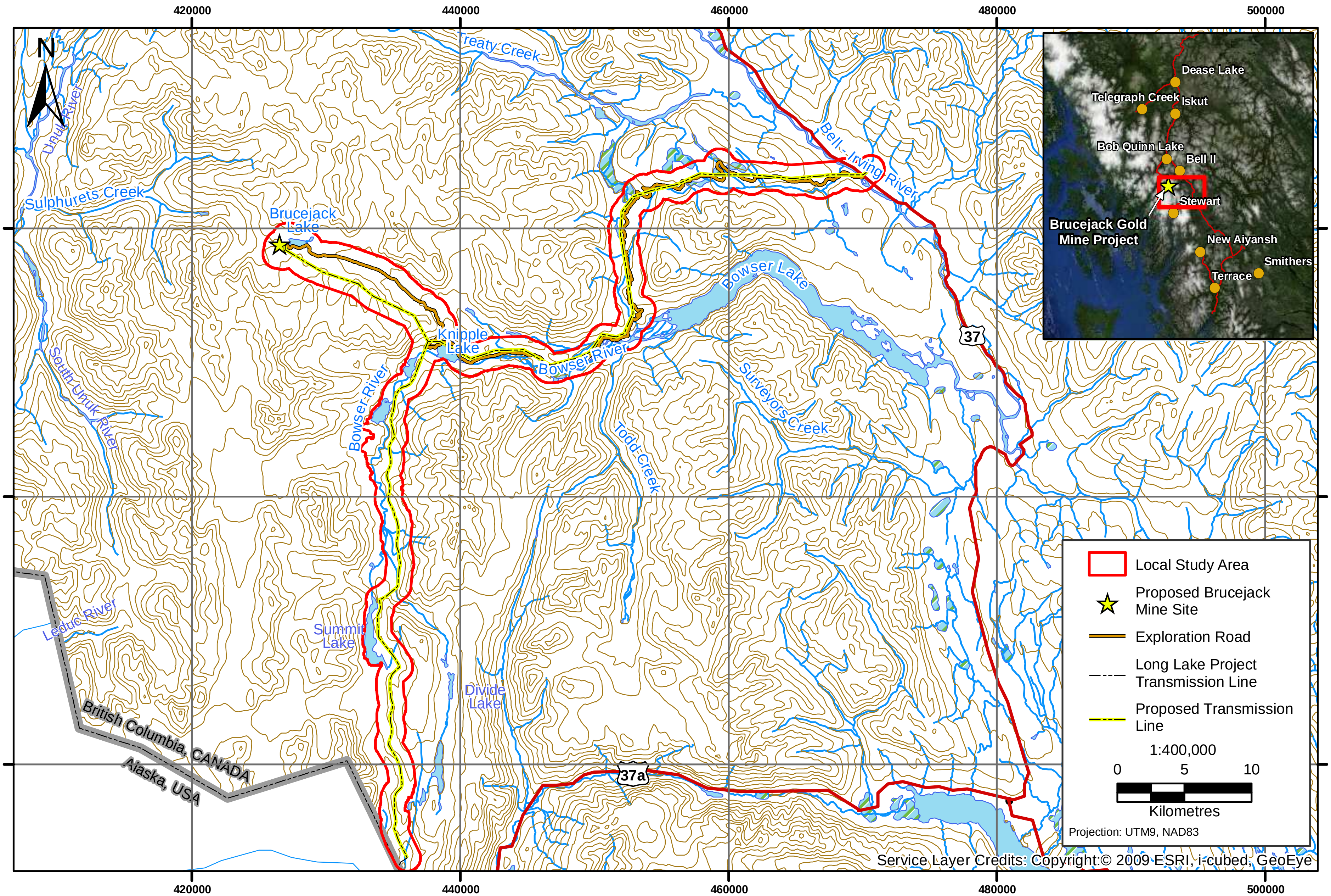

Figure 5-2

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Brucejack Gold Mine Project Archaeological Local Study Area (LSA)

Figure 5-2

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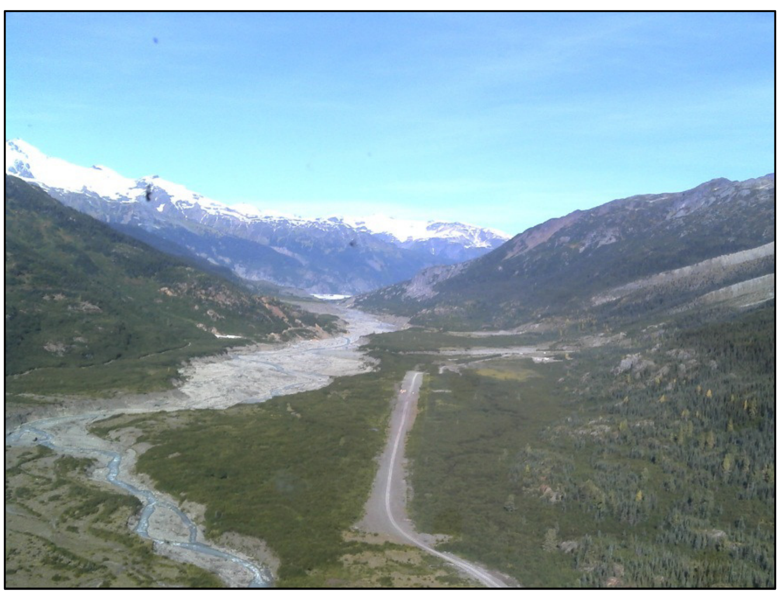
the warmer drier Hypsithermal Interval. Increasing snowfall beginning ca. 4,000 BP which forced the caribou eastwards (Ryder 1987). Over the past 6,000 years the upper Bowser watershed, which drains the southeastern portion of the RSA, has experienced several periods of wetter, cooler temperatures including a major glacial advance (2,800 - 2,200 BP) and the recent “Little Ice Age” that began approximately 500 BP and peaked in the early to mid-17th century (Clague and Mathewes 1996). During this period, the Bowser River was dammed by the Knipple Glacier and the large unnamed glacier between the Knipple and Frank Mackie glaciers. Flooding of the lower Bowser Valley may have been caused by breaches in these ice dams or recession of these glaciers (Clague and Mathews 1992).

Neoglacial activity had significant impacts on the landscape, particularly around proglacial Tide and Summit lakes. During the Pleistocene, large proglacial lakes, such as these, had a major influence on ice sheets and climate in the Northern Hemisphere (Clague and Mathews 1992).

Tide Lake was the largest ice-dammed lake in British Columbia; situated between Berendon Glacier and Frank Mackie Glacier. At its peak, the lake was 9 km long, nearly 2 km wide, and approximately 200 m deep at its ice dam at the Frank Mackie Glacier ice dam (Plate 5.1-1). Water may have regularly escaped north out of the lake along high bedrock channels at the glacier’s eastern edge or seeped through the ice dam draining into Bowser River. The lake was known to periodically drain suddenly during the nineteenth and twentieth centuries due to rapid tunnel enlargement at the base of the ice dam. This caused catastrophic floods downstream in the Bowser Valley. In the late 1800s, a flood was reported to have completely destroyed an Aboriginal settlement that was never reoccupied (Clague and Mathews 1992). In 1931, the ice dam was breached for the last time due to thinning of the glacier and Tide Lake emptied. Heavily silted water scoured the Bowser Valley and flowed down the Nass River to Observatory Inlet where it impacted the commercial fishery, sinking the fishing nets due to the extra weight of the silty water (McLeod and McNeil 2004). A small lake persisted against the moraine left by the receding toe of Frank Mackie Glacier until 1990. The upper reaches of Bowser River and Betty Creek now flow across what was once the lake bed and have incised channels up to 30 m deep in the sediments left by the proglacial lake (Clague and Mathews 1992).



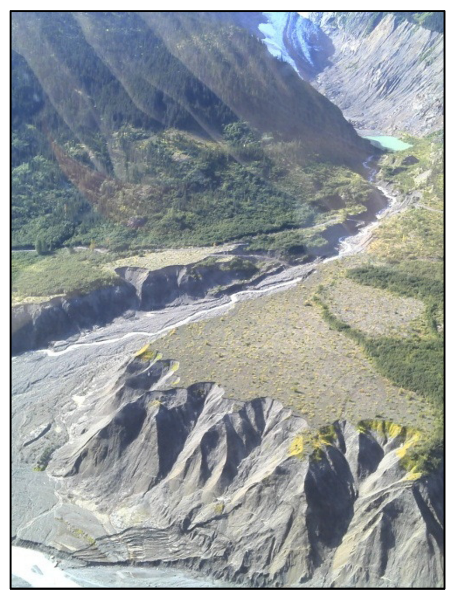


Plate 5.1-1. Tide Lake Flats. L: View north toward Frank Mackie Glacier (just visible above photo centre). R: Deeply incised proglacial lake sediments at the northwestern end of the lake basin.

Summit Lake, situated between the northern arm of the Salmon Glacier and just south of the Berendon Glacier, has had a similar, though more recent, history. The lake is situated between the northern arm of the Salmon Glacier and just south of Berendon Glacier. During operation, the Granduc Mine housed crews in the Tide Lake Camp near the toe of Berendon Glacier. The camp originally drew its water from Summit Lake, which had drained stably to the north into the Bowser River. In 1961, the lake drained suddenly and unexpectedly to the south through a 12 km melt tunnel beneath the Salmon Glacier, due to the glacier's thinning ice. The resulting flood released a huge amount of water into the Salmon River badly damaging the Granduc Access Road and washing out a bridge. The lake now fills and drains annually, though much less dramatically than the 1961 flood. The reduction of ice pressure now favours the formation of a drainage tunnel which releases water from Summit Lake into the Salmon River generally during the summer months (Clarke and Holdsworth 2002).

Volcanism associated with the Lava Fork and Second Canyon cones, to the southwest of the RSA, significantly shaped the upper Unuk region during the Holocene. The Lava Fork volcano is believed to be the most recently active volcano in Canada, last erupting approximately 150 years ago. During the Holocene, at least three flows of lava emanated from Lava Fork creating a number of lakes, including Blue Lake in Alaska and Lava Lake in British Columbia. The canyon at the confluence of the Unuk and Blue rivers was created when a flow of lava crossed the valley. Similarly, undated lava flows from the Second Canyon Cone created the second and third canyons on the Unuk River (Hauksdottir, Enegren, and Russell 1994; Geological Survey of Canada 2010).

5.1.2 Biophysical Setting

The LSA falls primarily within five biogeoclimatic zones: Coastal Mountain-heather Alpine, Boreal Altai Fescue Alpine, Engelmann Spruce – Subalpine Fir, Mountain Hemlock and Interior Cedar Hemlock.

The Interior Cedar Hemlock (ICH) zone is the lowest elevation zone within the RSA located along the Bell-Irving River, around Bowser Lake, along lower Scott Creek, and extending west along lower Wildfire Creek (Plate 5.1-2). The ICH zone is characterized by cool wet winters and warm dry summers. The dominant tree species are western hemlock and subalpine fir, though Roche spruce, a hybrid of Sitka and white spruce, are also found. Of the annual precipitation in the ICH, 25 to 50% (500 - 1,200 mm) falls as snow.

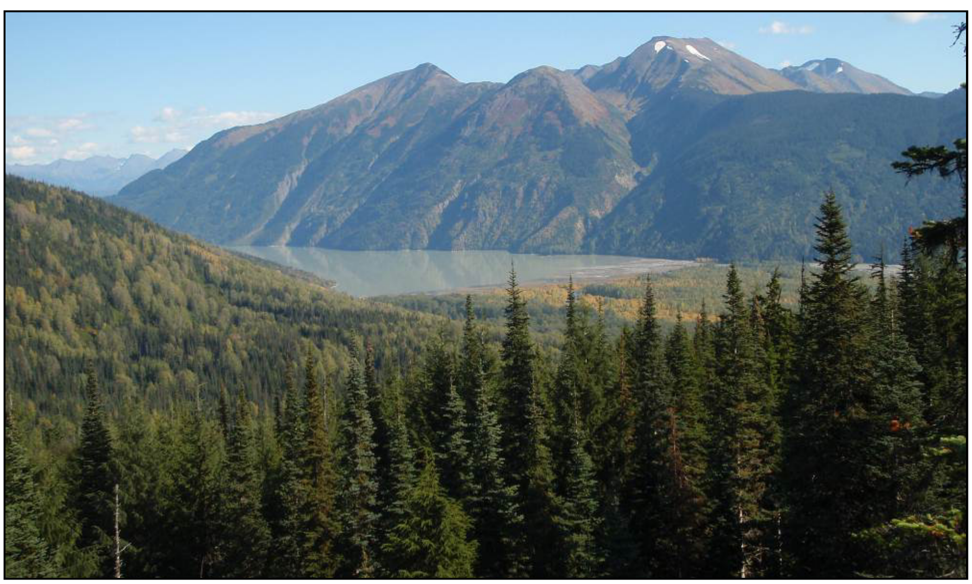


Plate 5.1-2. View of the Interior Cedar Hemlock (ICH) zone facing southeast towards the eastern end of Bowser Lake (photo centre).

Black and grizzly bears are the most common large animals found in this zone supplementing their diet of salmon with the abundant Alaskan blueberries and black huckleberries during the summer and fall and hibernating through the long cold winters (Meidinger and Pojar 1991).

The Engelmann Spruce – Subalpine Fir (ESSF) zone is located around Todedada Lake, upper Scott Creek, and upper Wildfire Creek. The ESSF zone is characterized by long cold winters with a short growing season. Engelmann spruce and subalpine fir are the dominant tree species. More than half of the annual precipitation (50 to 70% - 700 to 2,200 mm) falls as snow resulting in a deep snow pack that is often several metres thick. Black bear, grizzly bear, and moose are common in this zone, especially in subalpine parkland areas, and some fur-bearing species such as marten, fisher, wolverine, and red squirrel are also found here. Additionally, mountain goat and golden eagle are common to the ESSF, but are typically found along south-facing terrain (Meidinger and Pojar 1991).

The Mountain Hemlock (MH) zone is located along the Brucejack Transmission Line – South Option and along the western edge of the Knipple Glacier. Mountain hemlock and amablis fir are the dominant tree species, though at higher elevations the forest cover decreases becoming subalpine parkland with a patchy distribution of subalpine fir trees. The MH zone has a short growing season with 700 to 5,000 mm of annual precipitation, 20 to 70% of which falls as snow. Wildlife is less diverse than in other zones due to its typically steep, rugged landforms and glaciers. Large mammals may include grizzly bear and mountain goat. Birds in the MH zone include golden eagles, ptarmigans, owls, woodpeckers, and various other smaller species (Meidinger and Pojar 1991).

The Coastal Mountain-heather Alpine (CMA) zone is located in portions of the RSA around Brucejack Lake (Plate 5.1-3). The CMA is home to ice fields and glaciers as well as alpine meadows and tundra. The treeline in this environment is at lower elevations due to the heavy and prolonged winter snow cover. Within the RSA the treeline consists of stunted mountain hemlock and subalpine fir "krummholz" tree patches. Summer temperatures are cool due to maritime influences and the harsh winter climate limits use of the alpine environment by wildlife in many areas. Within the CMA the lee of the Coast Mountains are home to some of the densest populations of mountain goat in the world. Caribou and bighorn sheep also live here. During the summer and fall grizzly bear forage in the alpine meadows (Meidinger and MacKenzie 2006).

The Boreal Altai Fescue Alpine (BAFA) zone is located in the high alpine of the RSA above the CMA. This zone is largely composed of glaciers and ice patches. The BAFA vegetation is composed largely of dwarf willows, grasses, sedges, and lichens. Both small mammals such as the hoary marmot, arctic ground squirrel, and Siberian lemming, and larger mammals including Stone sheep, mountain goat, Grizzly bear, gray wolf, and wolverine, spend time in the BAFA zone (Meidinger and MacKenzie 2006).

5.2 CULTURAL SETTING

The history of this part of the province includes three broad ethnographic groups who utilized the region: the Tsimshian, the Tahltan, and the Tsetsaut. In response to a variety of influences, including intermarriage, migration, warfare, trade, and eventually the influence of the fur trade, traditional territories fluctuated and changed hands over many generations. Aboriginal groups in the region today trace ties to these ethnographic groups; the groups closest to the Project include the Skii km Lax Ha, Nisga'a Nation, Gitanyow, Gitxsan, and Tahltan.

The Tsimshian, Tahltan, and Tsetsaut ethnographic groups share similar social and cultural patterns. These common traits were developed to sustain their lifestyle in the upper Nass, Skeena, and Stikine watersheds with similar demands from climate, resource availability, and movement of large game. Access to the coast, rivers, and mountains in the region had a strong influence on land use patterns for these groups. Salmon fishing played a central role for these groups which allowed for village sites to develop around important fishing locations while hunting and trapping in winter months was common. Plant and berry gathering was also an important activity providing food resources as well as medicinal resources and utilitarian materials (Duff 1981, Halpin and Seguin 1990, MacLachlan 1981, Rescan 2013).

Plate 5.1-3. View northwest of Brucejack Lake within the Coastal Mountain-heather Alpine (CMA) Zone. Brucejack Exploration Camp is visible (bottom left).

Dialects within the same language family is also a common thread for the Gitanyow, Gitxsan, and Nisga'a Nation which are all part of the Tsimshianic language family. The Gitanyow occupying lands in the upper Skeena River watershed and along the Kitwanga River, the Gitxsan occupying lands in the upper Skeena River watershed, and Nisga'a occupying lands in the lower Nass River watershed (YDLI 2006, Rescan 2013).

Similarly, the Tahltan and Tsetsaut are part of the Athapaskan language family with the Tahltan occupying lands in the upper basin of the Stikine River and on the Stikine Plateau. Ethnographic accounts suggest that the Tsetsaut went into decline in the early 20th century and the remaining population may have been incorporated into neighbouring groups (Boas 1895, 1896, 1897; Duff 1959, 1981; Sterritt et al. 1998; YDLI 2006). The Tsetsaut occupied the area around Observatory Inlet, Portland and Behm canals, and inland regions around Meziadin Lake and the Nass, Skeena, and Stikine rivers. However, the Skii km Lax Ha refer to their territory as Laxwiiyiip or Eastern Tsetsaut and assert that their territory extends from the north side of Cranberry River, along the Nass and Bell-Irving rivers to Ningunsaw Pass with historical and current use extending as far northwest as the Iskut River. The Skii km Lax Ha are not currently recognized by the Government of Canada as a "band" as defined by the *Indian Act*. They are considered a *wilp* of the larger Gitxsan Nation and descendants are typically members of bands within Gitxsan Nation (Rescan 2009, 2013).

Nisga'a Nation signed a treaty with Canada and British Columbia in 1998, the Nisga'a Final Agreement (1999), which came into effect on May 1, 2000. Key provisions included in the treaty were the transfer of Crown Land to the Nisga'a Nation, the establishment of a water reservation, the protection of Nisga'a interests (such as fishing and wildlife harvesting) in the Nass Area and Nass Wildlife Area, the establishment of Bear Glacier Provincial Park, and the designation/protection of the Treaty Creek Site (HdTj-1; see Sections 5.6 and 7.4.1), among others.

Detailed ethnographic information on these First Nations and Nisga'a Nation can be found in the following sources: Adams (1973), Albright (1980, 1982, 1983, 1984), Barbeau (1929, 1950a, 1950b), Benyon (1941), Berthiaume (1999), Daly (2005), Dawson (1887), Drucker (1965), Duff (1959, 1964, 1981), Dunn (1995), Emmons (1911), Friesen (1985), Garfield (1931, 1939), Gitxsan Chief's Office (n.d.), Halpin (1973), Halpin and Seguin (1990), Hodge (1912), Inglis, Hudson, Rigsby, and Rigsby (1990), Jenness (1927), MacDonald and Cove (1987), MacLachlan (1981), McDonald (2003, 2006a, 2006b), McIlwraith (2007), McNeary (1976), Menzies (2006), Miller (1997), Miller and Eastman (1984), Morice (1893), People of 'Ksan (1980), Sapir (1915, 1920), Seguin (1984, 1985), Shortridge (1919), Sterritt et al. (1998), Teit (1906, 1912, 1956), Thompson (2007), Thorman (n.d), and White (1913).

5.3 HISTORIC BACKGROUND

The remoteness of the RSA from early post-contact administrative, missionary, and fur trade centres has resulted in a relatively short and recent period of time being documented by written accounts. The closest fur trade posts to the RSA include Fort Stikine/Wrangell (120 km west, in Alaska), Fort Connolly (150 km east), Fort Babine (190 km southeast), and Fort Simpson (200 km south). As late as 1911, the RSA is shown on maps as a blank spot missing key geographic features such as Bowser Lake (British Columbia Department of Mines 1912). However, the region has seen intensive mineral exploration activity through the 20th century. This section provides a brief overview of some of the historic events that have helped shape the history and use of the region.

<u>Communication</u>

With the need for more efficient and expedient communication between North America and Europe, attempts to connect the two continents by telegraph were undertaken in the mid-1860s. Perry McDonough Collins undertook the construction of a telegraph line in 1865 which was expected to cross approximately 1,300 km of British Columbia (beginning in New Westminster), pass across approximately 2,900 km of Russia-America (Alaska), crossing under the Bering Strait, and continue across approximately 11,200 km of Russia, terminating in Europe. Construction on the project was started in the summer of 1865 and continued until March of 1867 when the success of the telegraph cable across the Atlantic Ocean rendered the project unnecessary. Despite the short lifespan of the project, significant efforts had been spent to locate and clear a suitable route for the proposed line with crews working from the north and the south (Robb 1966).

By the time the project was abandoned, work on the southern portion of the line was more complete than that of the north. In the south, telegraph line had been strung and maintenance cabins established between New Westminster and Kispiox. However, in the north, exploration and survey were still underway. In January of 1867 James Schaft led a survey crew which departed from Buck's Bar on the Stikine River and travelled south to within 20 miles of the Bell-Irving River before their provisions ran out. Schaft set up camp and sent two members of his party, Miller and Rankin, south to attempt to purchase salmon from the local Aboriginal people. Miller and Rankin travelled along the Bell-Irving River for seven days, past the RSA, likely reaching Meziadin Lake before they turned back unable to find anyone to trade with. In March and April, P. J. Leech and another survey party retraced Miller and Rankin's path down the Bell-Irving River, passing Bowser Lake, before reaching Grease Harbour at the mouth of the Nass River in May of 1867 (Sterritt et al. 1998).

The need for improved communication to the region was recognized during the Yukon Gold Rush in 1897. In 1899, the Dominion Government undertook to complete the telegraph line from Quesnel to Atlin, completing the project in 1901 (Miller 2004, Newman 1995). From Hazelton to Telegraph Creek, the line passed through rugged terrain with the line running up the Kispiox and Skeena Rivers, crossing the Nass and Bell-Irving Rivers, paralleling the Iskut River until its pass turned northwest where it ran up Raspberry Pass to Mess Creek and on to the Stikine River. Due to the difficult terrain through this section, 13 stations/cabins were established to provide line maintenance, two of which are just north of the RSA (HeTk-3 and HeTl-2; see site forms on file with the Archaeology Branch under *HCA* Heritage Inspection Permits 2007-200 and 2007-258).

Mineral Exploration and Mining

With the onset of the Cassiar Gold Rush in the 1870s, the provincial government sponsored surveys in 1874 and 1875 to identify a land route to the Cassiar gold fields. On May 27, 1875 a survey party lead by James Gardiner and Vital LaForce (a veteran of the Collins Overland Telegraph surveys) travelled south from the Stikine River through the Klappan drainage to *Gitanyow*. With a *Gitanyow* guide they travelled north up the Nass and Bell-Irving rivers reaching Bowser Lake on August 14, 1875 (Sterritt et al. 1998).

During the 1880s prospectors were extracting gold from the gravels of Sulphide (Sulphurets) Creek accessing their claims using a foot trail they had blazed along the north bank of the Unuk River from Burroughs Bay, Alaska (British Columbia Department of Mines 1904, 1936). In 1893, placer gold was found in the region and Ketchikan based prospectors headed to the area during the 1890s (British Columbia Department of Mines 1936). The 1903 Minister of Mines Report (British Columbia Department of Mines 1904) reported that prospector who had worked on Sulphurets Creek for the previous eight years had recovered coarse gold deeming the region to be worthy of development if the transportation issue could be solved.

The 1920s and 1930s were the heyday of mineral exploration in the region (Plate 5.3-1). Many exploration and mining projects were underway in the hills around the Salmon River. Some of the more notable projects included: the Big Missouri Mine north of Hyder (responsible for the Long Lake dam); the East Gold Group which staked claims along the western perimeter of Tide Lake after it drained for the last time in 1931; the Mountain Boy Group on lower American Creek; the Morris Summit Mine just east of Summit Lake (in the 1940s this mine was renamed Scottie Gold); and the Dunwell Mine which was north of Stewart in the Bear River valley, among countless other exploration projects which have left their mark on the landscape (McLeod and McNeil 2004).

Since 1918, the Premier Mine has been responsible for much of the prosperity of the towns of Stewart and Hyder and its production record makes it one of the most productive precious metal mines in British Columbia. The area was first staked in 1910 and after hitting high grade ore, the property went into production in 1919. By 1921, mine facilities and camps were in place as well as a tramline. In the 1930s, the mine had approximately 200 employees and the area about the mine had developed into a small self-contained town. In 1936 ore grades began to deteriorate but the mine continued to operate until 1952 when it was closed due to low metal prices. The mine was reopened in 1956. Things at the mine were quiet in the 1990s (McLeod and McNeil 2004). However, the mine is once again being redeveloped and explored by Ascot Resources Ltd. (Ascot n.d.).

In the fall of 1928 claims were staked along the north side of Treaty Creek (formerly 20 Mile Creek). The claims were accessed from the south via trails from Meziadin Lake and the Nass River Valley. However, as the assay results proved to be low grade ore, the claims were subsequently abandoned (British Columbia Department of Mines 1923, 1932). Around the same time, in 1929, interest in the mineral potential of the Unuk River watershed resulted in an influx of Ketchikan and Stewart based prospectors, including Tom McQuillan, T. Terwilligen, Arthur Skelhorne, and brothers, Bruce and Jack Johnstone. Interest in the region continued and in 1932 two groups of prospectors explored the source of the Bell-Irving River; however despite reporting encouraging results, there are few records of any further work (British Columbia Department of Mines 1933).

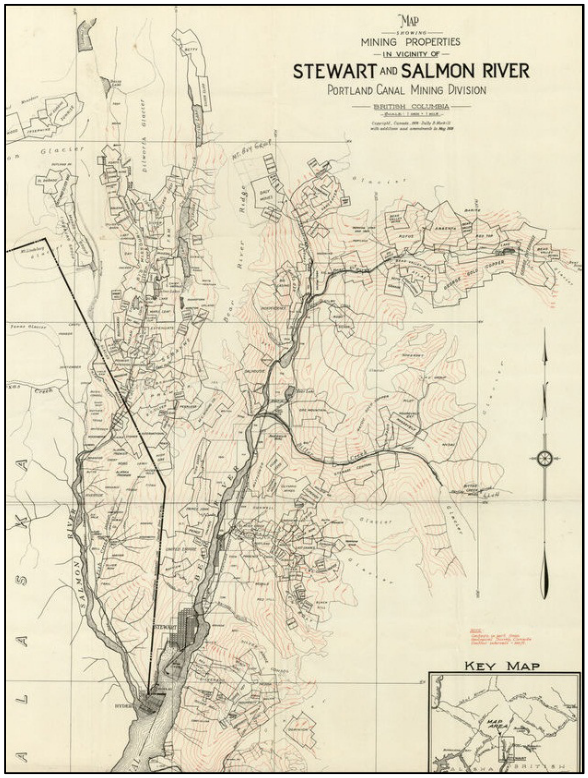


Plate 5.3-1. Portion of a 1929 map of mineral claims in the Stewart and Salmon River area (Morkill 1929).

Mineralization at the Brucejack property was first identified in 1935 when Bruce and Jack Johnstone staked claims in the area (British Columbia Department of Mines 1935). Modern exploration at the Brucejack area did not commence until 1960. Since then, companies including Granduc, Esso and Newhawk have staked claims and undertaken exploration activities (P & E Mining Consultants Inc. 2009). The Newhawk operations used a barge across Bowser Lake and road over the Knipple Glacier to access the Sulphurets Project, an underground exploration project at the currently proposed Brucejack Mine Site, from Highway 37. During the late 1980s a small underground mining operation was developed by Catear Resources at the Goldwedge property northwest of Brucejack Lake. The mine operated briefly beginning in 1988 and included a 50-ton-per-day mill and ancillary structures.

Copper was discovered and staked in 1951 near the Leduc Glacier. The property was optioned to Granby Mining who formed a subsidiary named Granduc (a combination of Granby and Leduc). The site was approximately 34 km north of Stewart, the closest port. Crews accessed the site by aircraft landing on the glacier and by tracked machine across the Salmon Glacier from the Premier Mine Road. The ore was transported through an 18 km tunnel, which was constructed in 1965, passing under the Berendon, Frank Mackie, and Leduc glaciers to the mill at the end of the Tide Lake flats. A road was also constructed in 1965 so that ore could be trucked out to Stewart. An airstrip was also built on the Tide

Lake Flats to move freight to and from the site before the road to Stewart was complete. Production at the mine commenced in 1970 and ceased in 1978 with the project barely making profits. In 1979, the project was taken over by Imperial Oil who operated the mine until 1983 when it was shut down and the plant totally dismantled (McLeod and McNeil 2004, Clarke and Holdsworth 2002). In 2010, Castle Resources Inc. acquired the project and has been conducting additional mineral exploration in the hopes of redeveloping the Granduc Mine (SRK 2012).

Transportation

The Stewart-Cassiar Highway, Highway 37, roughly parallels the eastern side of the RSA and runs through its northeastern corner. The highway runs north from Hazelton to the Yukon/British Columbia border and has a branch, Highway 37A, from Meziadin Lake to Stewart. The construction of the highway commenced in 1956 and was completed in 1972 (MOT 2000, McLeod and McNeil 2004). With the discovery of asbestos in the Cassiar District, the original highway project was intended as an access route to move the asbestos to the shipping port in Stewart, at the head of Portland Canal. The highway joined several other rudimentary logging roads at Meziadin Junction, thereby linking Hazelton to the north and provided a major alternative to the Alaska Highway (Harvey 1999).

Borders, Parks, and Protected Areas

The Alaska-British Columbia border lies to the west of the Project and forms the southwestern corner of the RSA. Until the early 1900s, the location of the boundary line was the cause of much confusion and international dispute. Alaska was once owned by Russia, a right based on their establishment of trading posts along the coast (e.g. Fort Wrangell, later known as Fort Stikine), which was confirmed in a treaty between Great Britain and Russia in 1825. The United States purchased Alaska in 1867 from Russia, inheriting maps and generalized boundary definitions which differed from the boundary British Columbia believed to be in place. The dispute was finally settled in 1903 by a tribunal between the United States, Canada, and Great Britain. Preliminary survey work for the boundary established by the tribunal was underway the following year. Between 1907 and 1914 survey crews worked on marking the actual boundary and placed 200 permanent monuments along the boundary line between Mount St. Elias and Demarcation Point on the Arctic Ocean (FitzGerald 1951, Farr n.d.).

The first parks in the region were established in the 1970’s, including Misty Fjords National Monument southwest of the RSA in Alaska (established 1978; National Parks Service 2003) and the Ningunsaw Ecological Reserve in BC (established 1975; BC Parks 2011a). In 2001, the Cassiar-Iskut-Stikine Land and Resource Management Plan established Ningunsaw Provincial Park adjacent to the Ningunsaw Ecological Reserve and Border Lake Provincial Park along the Unuk River at the Alaska-BC border (BC Parks 2011b and 2011c).

5.4 PREVIOUS ARCHAEOLOGICAL STUDIES

HCA permit reports for archaeological work carried out for several previously proposed developments in the region were reviewed to help inform this study. While these reports, summarized briefly in this section, were reviewed to help informed the study, they were not relied upon to determine areas of archaeological potential for the study.

5.4.1 Kerr-Sulphurets-Mitchell Project

Since 2008, Rescan has conducted archaeological assessments for the Kerr-Sulphurets-Mitchell (KSM) Project, a proposed copper-gold-molybdenum mine that is immediately north of and adjacent to the Project. This work was conducted under *HCA* Heritage Inspection Permits 2008-0128 and 2012-0192 during which thirty-four archaeological sites were identified in the KSM Project area. Obsidian from some of these sites has been chemically sourced to quarries near Mount Edziza, over 100 km to the north (Seip et al. 2012a, Farquharson et al. 2012).

5.4.2 Sulphurets Access Roads

A proposed access road from Highway 37 to the Newhawk Gold Mines Sulphurets Property was assessed in 1987 under *HCA* Heritage Inspection Permit 1987-039. The proposed access road was to travel west from Highway 37 along the north side of Treaty Creek turning south along the west bank of Todedada Creek, past Todedada Lake and continuing south to the confluence of Scott Creek and the Bowser River. The proposed road would then travel along the north side of the Bowser River Valley to Knipple Lake before turning northwest to climb over the Knipple Glacier. During the assessment of this route no heritage sites were identified (Bussey 1987a). A secondary proposed access road option that travelled along the north side of Wildfire Creek was also assessed as having generally low to no heritage potential for significant archaeological sites (Bussey 1987b). A portion of the road that was assessed was constructed in the late 1980s between Bowser Lake and the Knipple Glacier which connected to a barge system which moved equipment and supplies between Highway 37 and the head of Bowser Lake. The barge-exploration road was used through the 1990s until exploration activities were discontinued (Cypress Forest Consultants Ltd. 2011).

5.4.3 Northwest Transmission Line Project

BC Hydro conducted an AIA for the Northwest Transmission Line (NTL) Project under *HCA* Heritage Inspection Permits 2007-200 and 2007-258. This linear project runs from the Bob Quinn substation on the Eskay Creek Mine access road south to Terrace and is located to the northeast of the RSA. Final permits for these *HCA* permits have not yet been completed (see documentation for *HCA* Heritage Inspection Permits 2007-200, 2007-258 on file with the Archaeology Branch).

5.4.4 Upper Bell-Irving Watershed Archaeological Overview Assessment

An Archaeological Overview Assessment (AOA) of the Upper Bell-Irving Watershed was conducted in 2006 under *HCA* Heritage Inspection Permit 2006-193 which included an archaeological potential model that takes in the RSA. The potential model was created for use by Timber Baron Contracting Ltd., a forestry company, and identified areas of potential along the Bell-Irving River, Scott Creek, Todedada Creek, and around Todedada Lake. The model also identified high potential locations that have experienced recent glacial recession where ice patch archaeology may be feasible (Pegg and Dodd 2007).

5.4.5 Kalum and North Coast Forest Districts Project

Archaeological assessments were carried out under *HCA* Heritage Inspection Permit 2006-193 for the Kalum and North Coast Forest Districts which focussed on a number of forestry development areas, some of which fall within the northern and eastern sides of the RSA. The study documented a number of archaeological sites in the region ranging from a historic burial site (which is within the RSA on Boswer Lake but not in proximity to any current Project components), lithic scatters, and culturally modified tree sites (Marshall, Marr, and Palmer 2008).

5.4.6 Eskay Mine Project

A heritage resource assessment for the proposed Eskay Creek Mine to the north of the RSA was conducted in 1990 under *HCA* Heritage Inspection Permit 1990-81. The study focussed on the area around Tom Mackay Lake and Little Tom Mackay Lake. A large chert lanceolate point was found in shallow water, along the edge of a small lake northeast of Little Tom Mackay Lake. Extensive shovel testing in the area of the isolated find turned up no evidence of additional prehistoric material. This point was recorded as an isolated find (HdTo-IF#1). A small cabin dating to the 1930s, likely associated with early mineral exploration, near the Eskay Creek Camp and a trapper's cabin near the confluence of Mackay and Ketchum creeks were also recorded (Rousseau 1990).

5.4.7 Iskut Mine Access Road

In 1990, a heritage resources overview assessment of the proposed Iskut Mine Access Road to the north of the RSA was conducted. The proposed road ran west from Highway 37, near Bob Quinn Lake, along the Iskut River to the Eskay Creek Camp with another branch extending west to Bronson Camp. No archaeological or heritage sites were located within the assessment area, although a historic cabin was located on a bank 400 metres below the Unuk River and Sulphurets Creek confluence (Brolly 1990).

5.5 PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES

Six previously recorded archaeological sites documented in the British Columbia Archaeological Site Inventory are located in the RSA. Four of the sites (HcTo-1, HdTn-1, HdTn-2, and HdTo-7), found at the northwestern edge of the RSA near the Sulphurets and Mitchell creeks, consist of small subsurface lithic scatters ranging in size from 5 to 200+ obsidian artifacts, some of which have been sourced to Mount Edziza (Seip et al. 2012a, Farquharson et al. 2012). HcTj-1 is situated on a prominent point on the northern shore of Bowser Lake which consists of two historic graves (documented as the graves of Simon Gunanoot, a historic figure in the area, and his father Nah-Gun) and a historic cabin and associated features (Marshall, Marr, and Palmer 2008); the burials are not in proximity to any current Project components. HdTj-1, located on the southern side of the confluence of the Bell-Irving River and Treaty Creek, is a historically significant battle site and commemorative location of a subsequent peace treaty reportedly between Nisga'a and the Tahltan. The site was listed as a Provincial Heritage Site as part of the Nisga'a Final Agreement (1999). See Section 7.4.1 for additional information.

Additionally, in the vicinity of Bowser Lake there are two locations that may have archaeological value. The first is Cache Point, the prominent point of land on the south side of Bowser Lake. The origin of the place name is not known, but the name has been in use since at least 1930 CE, and may relate to use of this location by surveyors or Aboriginal peoples as a food or supply cache (GeoBC 2011).

The second is an ethnographically documented village site located near Bowser Lake. The village is referred to by a number of names including *Aw-wee-zah* (Duff 1959), *Owidza* (Albright 1984) and "Tal Tan village" (Sterritt et al. 1998). The village may have been located near the eastern end of the lake (Albright 1984); however, its location is only roughly known from oral histories and historic accounts.

5.6 REGIONAL HERITAGE SITES

In 2008, a Community Heritage Registry was established for the Regional District of Kitimat-Stikine. The registry is an official list of important historic places in the district. For each site, a Statement of Significance detailing the heritage values and defining characteristics have been prepared. The eight sites currently on the Heritage Registry are:

- Telegraph Creek townsite;
- Hagwilget Canyon Bridge;
- Old Skeena Bridge;
- Butedale Cannery;
- Anyox Powerhouse;
- Yukon Telegraph Line;

- Simon Gunanoot Gravesite; and
- Meziadin River Fish Ladders.

Simon Gunanoot Gravesite, situated at Graveyard Point on the north shore of Bowser Lake, is the only site on the Community Heritage Registry located within the RSA. This location is recorded under the *HCA* as archaeological site HcTj-1 and the burials are not in proximity to any current Project components (see Section 5.6 and 7.4.1).

6. Methodology

Engineers and Scientists

6. Methodology

This cumulative archaeology baseline study is based on work conducted in 2010, 2011, and 2012. The study was conducted in accordance with the *Archaeological Impact Assessment Guidelines* (Archaeology Branch 1998) and the methodology outlined in the permit applications for *HCA* Heritage Inspection Permits 2010-0255 and 2011-0245 (Walker and McKnight 2011, Jollymore and Walker 2013). The general methodology is described below.

6.1 BACKGROUND RESEARCH

Prior to conducting field assessments, background information was first reviewed for the region surrounding the proposed Project, as described in Section 3.2. This particular avenue of investigations focussed on examining documentary data including ethnographic, historic, environmental, and archaeological studies, reports, and records, including a search of the British Columbia Archaeological Site Inventory using the RAAD application. When available, First Nations and Nisg̲a'a Nation land use and knowledge reports were reviewed and Appendices F and L of the Nisg̲a'a Final Agreement (1999) were reviewed. Environmental data from a variety of baseline studies conducted for the Project helped to inform the study, as well as publically available reports for Seabridge Gold Inc.'s KSM Project which is situated to the north of the Project.

6.2 ASSESSMENT OF ARCHAEOLOGICAL POTENTIAL

The archaeological field survey methods described below were used to identify archaeological resources within the LSA. Survey focussed on those areas within the development footprint that were identified in the field as having moderate or higher potential for containing archaeological sites.

The archaeological potential of a given area was assessed in the field, based primarily on the following factors: proximity to water sources or relict water courses, slope and aspect, food resource values (i.e., ungulate ranges, fish, berries), forest cover, local and traditional knowledge (when available), proximity to previously recorded archaeological or traditional land use sites, the possible use of an area as a travel corridor, the presence of ice patches, and the presence of microenvironmental features that are often associated with archaeological sites (such as terraces, hillocks/knolls, and breaks-in-slope). Factors thought to constrain archaeological potential include unbroken slope, steep or rough terrain, poorly-drained ground, and massive disturbance areas, such as avalanche chutes.

Additionally, an archaeological potential model created for Timber Baron Contracting Ltd. as part of an AOA of the Upper Bell-Irving Watershed, was reviewed, which included the RSA (Pegg and Dodd 2007). The model predates the current Archaeology Branch standards for potential modelling and although it was reviewed, it was not relied upon to assess potential.

For the Brucejack Transmission Line – South Option, a portion of the LSA along the upper Bowser and Salmon rivers which is characterized by steep mountainous terrain with numerous steep bedrock outcrops and loose talus slopes, a GIS slope class model was prepared prior to the field assessment to help inform the study. Areas with greater than 50% slope were considered to have no or low archaeological potential; such areas were aerially inspected during the field assessment to confirm the assessment of potential.

6.3 FIELD METHODS

Assessments took place during the 2010, 2011, and 2012 field seasons and included pedestrian surveys and subsurface shovel testing as a means of identifying archaeological sites.

In areas identified as having moderate or higher archaeological potential (see Section 6.2), extensive pedestrian survey was conducted. Additional areas considered to have low archaeological potential were selected for survey when considered appropriate to confirm the assessment. Examination consisted of a combination of systematic and judgmentally selected pedestrian survey traverses. Crew spacing during the pedestrian survey was determined based on terrain and visibility constraints, as well as the assessed archaeological potential of the area being examined, with spacing generally between 5 m to 20 m.

Ground surfaces were examined for trails, structures, artifacts, depressions, and other evidence of past human settlement or land use. Tree throws were visually examined for cultural materials. Standing trees, fallen logs and stumps were visually examined for cultural modification; as no pre-1846 Culturally Modified Trees (CMTs) were located during the field survey, the specific methodologies pertaining to these site types will not be described. Bedrock exposures and boulders were inspected for pictographs and petroglyphs, as well as for the possible presence of seams of flakeable lithic raw materials. Any talus slopes, caves, or rock crevices within the proposed development area were examined for evidence of burials or other cultural materials. Special attention was paid to examining high altitude areas, especially along glacial margins, snow and ice patches, and within passes. Artifacts identified on the surface during the pedestrian survey were recorded/photographed and collected.

Previous work in the region suggests that the majority of prehistoric archaeological sites discovered are small lithic scatters. Therefore, the subsurface testing strategy employed was devised to identify sites consisting of as little as four artifacts per m in a 100 m^2 site. Subsurface testing (shovel testing) was conducted in areas identified during the field assessment as having potential for buried archaeological material. Such areas included remnant river terraces, prominent knolls, areas along trails and/or along the banks of streams and lakes. Shovel testing was also conducted to determine the vertical and horizontal extent of any identified archaeological deposits, and to identify the nature, composition and integrity of the subsurface deposits.

The number and location of shovel tests was judgementally determined on a case-by-case basis, dependant on ground cover, terrain, and density of bush/forest, and assessment area. Landforms determined to have high archaeological potential were systematically shovel tested in clusters of 2 to 4 shovel tests at 5 m to 10 m intervals. Landforms with moderate archaeological potential had judgmental clusters of 2 to 4 shovel tests at 10 m to 20 m intervals. For small landforms identified as having moderate to high archaeological potential, cluster testing was implemented at a higher frequency dependant on the size of the landform. Areas of low potential were judgmentally and randomly tested. Quantitative analysis of each shovel test location was conducted taking into account the expected site type (target site area and artifact density) and the test location information (tested area, average individual test size, and artifact density). This information was analysed to determine the level of confidence in locating a potential site in the area.

Shovel tests were approximately 30 cm by 30 cm in size and penetrated both A and B soil horizons, and depending on the nature of the sediment accumulation and vegetation, continued until unweathered C horizon sediments or bedrock were encountered. Back dirt from tests was examined manually or screened through 6 mm mesh.

Site boundaries were defined on the basis of observed, natural and/or arbitrary limits:

- *natural boundaries* are those defined by the extent of associated landforms (e.g., terrace or ridge) or a limiting natural feature (e.g., stream), as appropriate;
- *observed boundaries* are those determined on the basis of the extent of archaeological materials or features, as observed in surface exposures, or through subsurface testing. This may also include the extent of observed archaeological potential as assessed in the field; and
- *arbitrary boundaries* are those which reflect artificial and/or administrative boundaries, such as property lines or cut block boundaries, or the presence of existing impacts or developments.

Both positive and negative shovel tests were numbered sequentially and the location of each shovel test plotted on a site map. Descriptions of the soil matrices in positive shovel tests were recorded in field notes. Each test location was described in terms of its area, terrain and defining soil characteristics. Artifacts and any other cultural materials encountered in shovel tests was collected. No evaluative subsurface test units were excavated. Artifacts, including surface finds, and any other cultural materials encountered in shovel tests were collected. Obsidian artifacts may be sent for x-ray fluorescence spectrometry (XRF) analysis to determine the origin of the raw material.

Archaeological sites identified were recorded in field notes, photographed and mapped by hip chain and compass (or equivalent method). UTM coordinates were taken by GPS at the site. The location of all sites was plotted on development plans and on NTS maps. All archaeological sites were recorded on BC Archaeological Site Inventory Forms and submitted to the Archaeology Branch. No human remains were encountered.

6.4 SIGNIFICANCE EVALUATION

The significance of sites recorded during this study was determined using the criteria for site evaluation found in the *British Columbia Archaeological Impact Assessment Guidelines, Appendix D* (Archaeology Branch 1998). The scientific public, ethnic, economic, and historic (if applicable) significance of each identified site was addressed when possible. As no previously unrecorded CMTs were located, no CMT evaluations were required for this study. Each identified site was assessed and rated as having a high, moderate, or low significance value. The definitions of each type of significance assessed are as follows:

- *Scientific Significance* – The potential of a site to provide information that could enhance our understanding of British Columbia's heritage resources, particularly its ability to contribute to various scientific disciplines, and its ability to contribute to an understanding of local and regional prehistory. For lithic sites, key considerations are the presence of unique or temporally-sensative artifact types, density and variety of archaeological material, and the potential for multi-components or datable material. Disturbed sites are generally rated as having low scientific significance;
- *Ethnic Significance* – The importance, significance, or value of a site as perceived by an ethnically distinct community or group;
- *Public Significance* – The potential a site has to enhance public awareness, interest, understanding, or appreciation of British Columbia's prehistoric or historic past, such as its interpretive, educational, and recreational potential;
- *Economic Significance* – The potential for a site to contribute or generate monetary benefits or employment through its development and use as a public recreational or educational facility; and
- *Historic Significance* – The degree to which as site represents or relates to important historical individuals or events.

6.5 DATA ANALYSIS METHODS AND TECHNIQUES

All collected artifacts were catalogued, described, and compared to existing regional typologies. Any formed tools encountered were described as to their shape, raw material, and manufacturing attributes. Appropriate metric attributes of artifacts were recorded. Lithic debitage was quantified and classified according to raw material, stage of manufacture and technological attributes. As no faunal remains or fire cracked rock were found, the specific methodologies pertaining to these pieces of data will not be described. The extent of sites containing discontinuous buried archaeological deposits was determined with reference to both the distribution of archaeological materials and the extent of associated landforms and areas of potential. Analysis focussed on a culture-historical framework and the functional and seasonal use of a site.

6.6 CURATION

All artifacts collected will be curated by the Royal British Columbia Museum (RBCM). The RBCM has confirmed their willingness to curate any artifacts collected. No increment cores, wedges, or complete stem round samples were collected for dendrochronological analysis.

7. Results

7. Results

The following section describes the results of the archaeological assessments carried out for the Project. In total 2,358 shovel tests were conducted in 99 locations, including in areas which were previously considered as locations for potential Project components, but that are no longer under consideration[1]. These assessments were carried out under *HCA* Heritage Inspection Permits 2010-0255 and 2011-0245 issued for the Project (Walker and McKnight 2011, Jollymore and Walker 2013). Figure 7-1 illustrates survey areas and shovel test locations for assessment areas discussed in this section. Sections 7.1 through 7.3 summarize the results of the archaeological baseline study. Section 7.4 summarizes the archaeological sites and built heritage and historic features identified during the study.

7.1 EXPLORATION ACCESS ROAD

The Exploration Access Road alignment was assessed in 2011 and has since been constructed. The alignment has been divided into five segments from east to west for ease of reporting. Of the eastern portion of the access road between Highway 37 and the Bowser River, 30 km of the 35 km were subject to pedestrian survey (Sections 7.1.1 and 7.1.2). From the Bowser River to the Knipple Glacier (Section 7.1.3), the access road follows a pre-existing road originally constructed by Newhawk (see Section 5.4). The access road then crosses the Knipple Glacier between the pre-existing road which ends at Knipple Lake to the pre-existing roads around Brucejack Lake (Section 7.1.4). The western portion of the access road (Section 7.1.5) follows pre-existing roads likely used during the Catear Mine exploration activities (Section 5.4). These access road segments are discussed in this section.

7.1.1 Access Road: Highway 37 to Scott Creek

The access road travels west from Highway 37 crossing the Bell-Irving River and immediately enters a series of cutblocks where it largely follows an existing logging road. After leaving the cutblocks, this section of the access road is heavily forested. The vegetation opens up as it passes through a series of marshes and ridges before descending down to Todedada Creek and then rising again near the source of Scott Creek. During pedestrian survey in this corridor shovel testing was conducted with the heaviest concentration placed along the ridges and knolls that rise out of sloped marshes (Plate 7.1-1). A total of 345 shovel tests were conducted at 16 locations within this 28.4 km section of the access road alignment. No prehistoric archaeological sites were located.

7.1.2 Access Road: Scott Creek to Bowser River

From Scott Creek, the access road runs south past Todedada Lake and then south along the east side of the Scott Creek Valley Valley until the alignment meets an overgrown road originally used by Newhawk near the Bowser River. Many of the ridges surrounding Todedada Lake were identified as having high archaeological potential and pedestrian survey was carried out covering approximately 44 ha around the perimeter of the lake. Evidence of historic mineral exploration or trapping activity was located in the area around Todedada Lake (see Section 7.4.3). The forest canopy is composed of spruce and fir trees above an understory of blueberries and saplings. In open areas around the lake shore and on avalanche chutes willow and alder are prevalent. The terrain around the perimeter of the lake includes numerous ridged peninsulas that extend out into the water and generally rise steeply away from the lake (Plate 7.1-2). A bench provides a large flat area between Todedada Lake and Todedada Creek. A total of 349 shovel tests were conducted in 24 locations. No prehistoric archaeological sites were located.

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[1] Detailed descriptions of all areas assessed and shovels testing conducted are provided in the AIA reports for *HCA* Heritage Inspection Permits 2010-0255 and 2011-0245 (Walker and McKnight 2011, Jollymore and Walker 2013).

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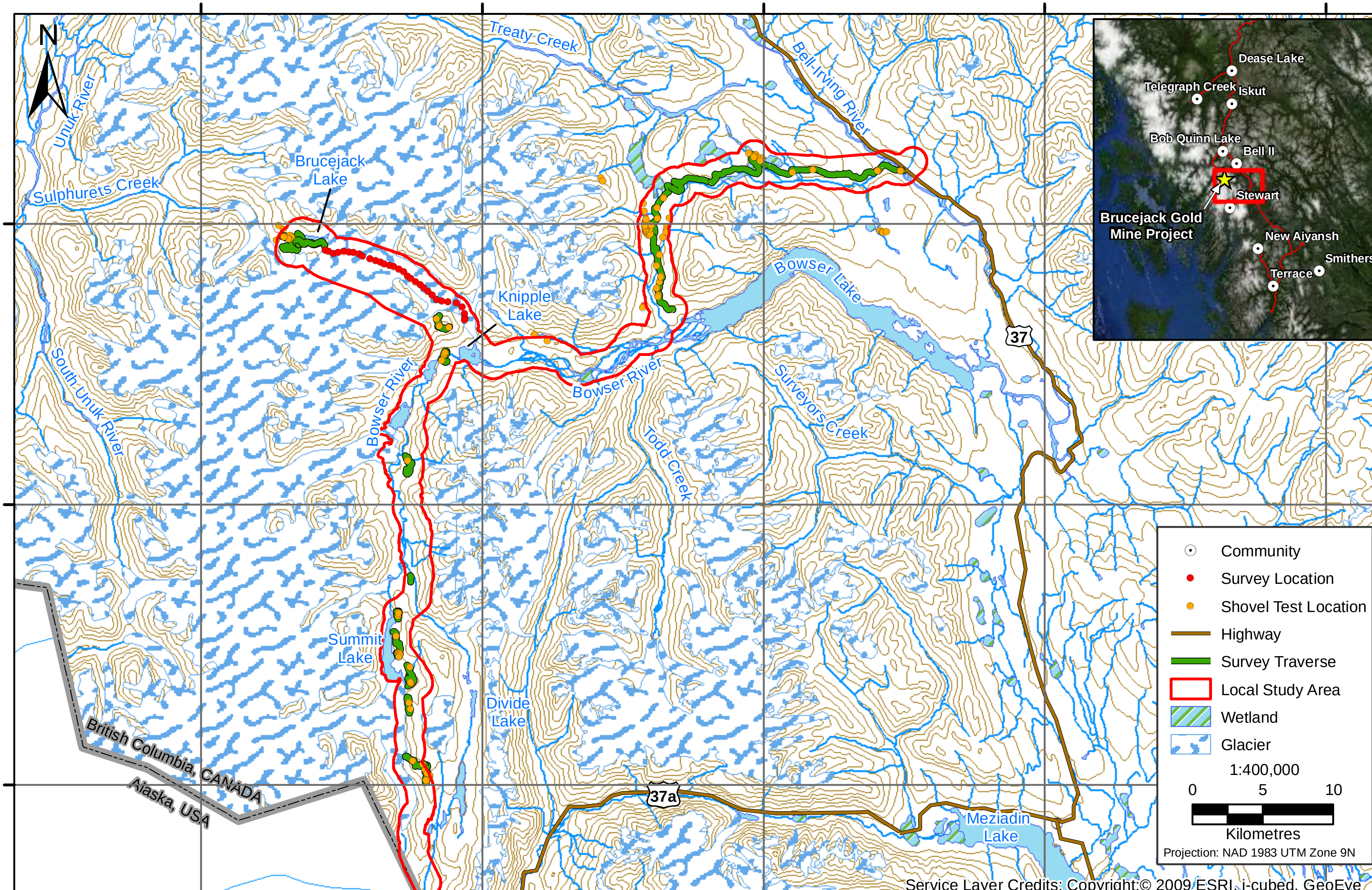

Figure 7-1

PRETIVM

Archaeological Survey and Shovel Test Locations

Figure 7-1

Rescan Engineers & Scientists

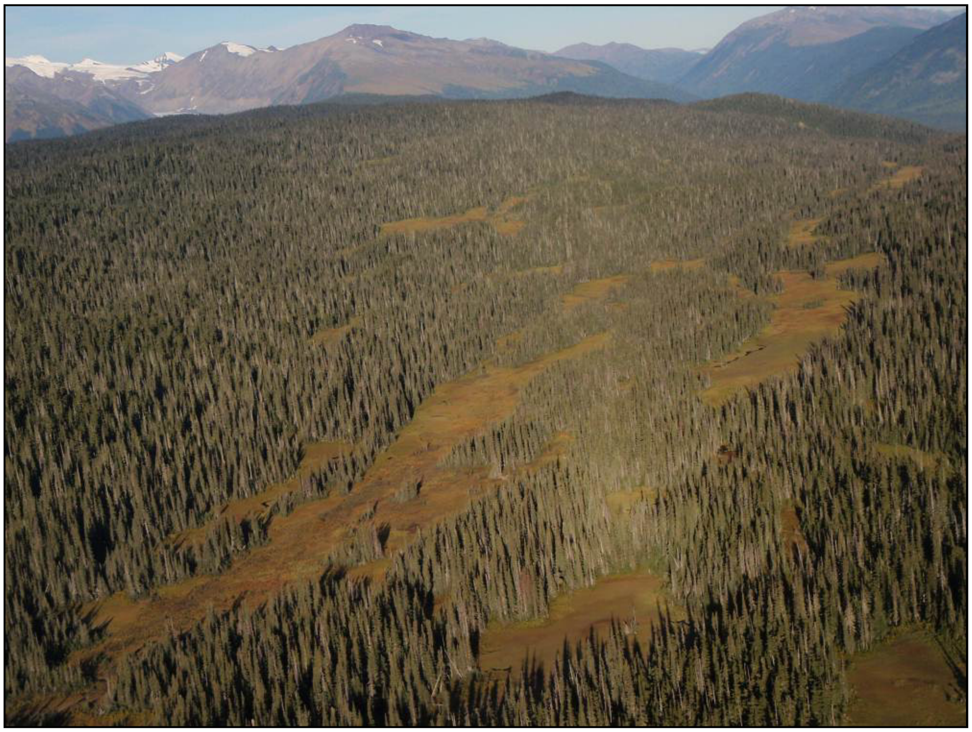

Plate 7.1-1. Undulating and marshy terrain typical of the area north of Wildfire Creek.

Plate 7.1-2. View north of Todedada Lake. The current access road alignment runs to the east of the lake.

7.1.3 Access Road: Bowser River to Knipple Glacier

Between Bowser River and Knipple Glacier the access road travels west through the Bowser River Valley to Knipple Lake and up to an arm of the Knipple Glacier, largely following a pre-existing overgrown road originally used by Newhawk (see Section 5.4). The terrain along this section of the access road is varied. The eastern and lower elevation section of the access road is forested, but as the access road rises towards the Knipple Glacier the ground surface becomes increasingly barren with no soil deposition. The terrain located to the north of the current access road alignment consists of a rocky bedrock ridge with steep slopes that drop down to the Bowser River Valley to the south and a small unnamed glacial lake to the north (Plate 7.1-3). The undulating ridge with numerous bedrock outcrops was assessed to contain areas of moderate archaeological potential and approximately 42 ha were subject to pedestrian survey. The canopy in this area consists largely of subalpine fire over blueberries and moss. Two relatively flat areas within the undulating terrain were tested and a total of 30 shovel tests were conducted. No prehistoric archaeological sites were located.

Plate 7.1-3. Terrain surrounding unnamed glacial lake, facing east.

7.1.4 Access Road: Knipple Glacier

This portion of the access road runs up the Knipple Glacier from Knipple Lake to the existing roads at the Brucejack Mine Site. The area is heavily glaciated and mountainous with numerous glaciers as well as snow and ice patches. Due to the emerging significance of ice/snow patches in archaeological research, and the Project's proposal to construct a segment of ice road over the Knipple Glacier, a review of the potential for archaeological materials to be present in these areas was undertaken (Appendix A). The potential for archaeological materials in glaciated or recently deglaciated portions of the access road on an active glacier or ice patch was assessed to be low.

In 2012, an assessment was conducted to determine if any archaeological concerns had been revealed through construction and use of the access road. With helicopter support, pedestrian survey of the glacier access road was conducted during the time of year when there was maximum exposure of the glacier ice. This survey included an examination of the road surface and the undisturbed glacial surface on either side of the road (Plate 7.1-4). The current state of the road was documented with photos taken in cardinal directions at 32 locations along the glacier. No evidence of archaeological material was located during the survey.

Plate 7.1-4. View south along the glacier access road on the Knipple Glacier.

7.1.5 Access Road: Western Project Area

After passing over the Knipple Glacier, the access road returns to rocky ground near an existing exploration road to the east of the Brucejack Exploration Camp. The road passes to the south of Brucejack Lake before proceeding on to the camp. The terrain in this area is very rocky with areas of tundra scrub vegetation (Plate 7.1-5). Two areas were tested and a total of 27 shovel tests were conducted and subsurface exposures were examined. The old Catear Mine to the west is evidenced by mine buildings and equipment that were left behind. No prehistoric archaeological sites were located.

7.2 BRUCEJACK LAKE AREA

The Brucejack Lake area is located in the alpine and subalpine around Brucejack Lake. The terrain is rocky and uneven with large areas of exposed rock and gravels (Plate 7.2-1). The current Brucejack Exploration Camp is located to the south of Brucejack Lake and an adit related to previous mining activity is located along Brucejack Creek that flows out of Brucejack Lake. Shovel testing was concentrated on the knolls, ridges, and terraces that surround a large marsh and a small lake to the west of the current camp. Pedestrian survey covered approximately 128 ha during which surface exposures were examined and a total of 242 shovel tests were conducted at nine locations. Prehistoric archaeological site, HcTn-1, was recorded on a surface exposure to the west of camp (see Section 7.4.2 for more information on HcTn-1). Evidence of previous mining activity was located in the area including two survey cairns, a mine adit, and the remains of the surface facilities of the earlier Catear Mine (see Section 7.4.3).

Plate 7.1-5. Rugged terrain within the western portion of the RSA.

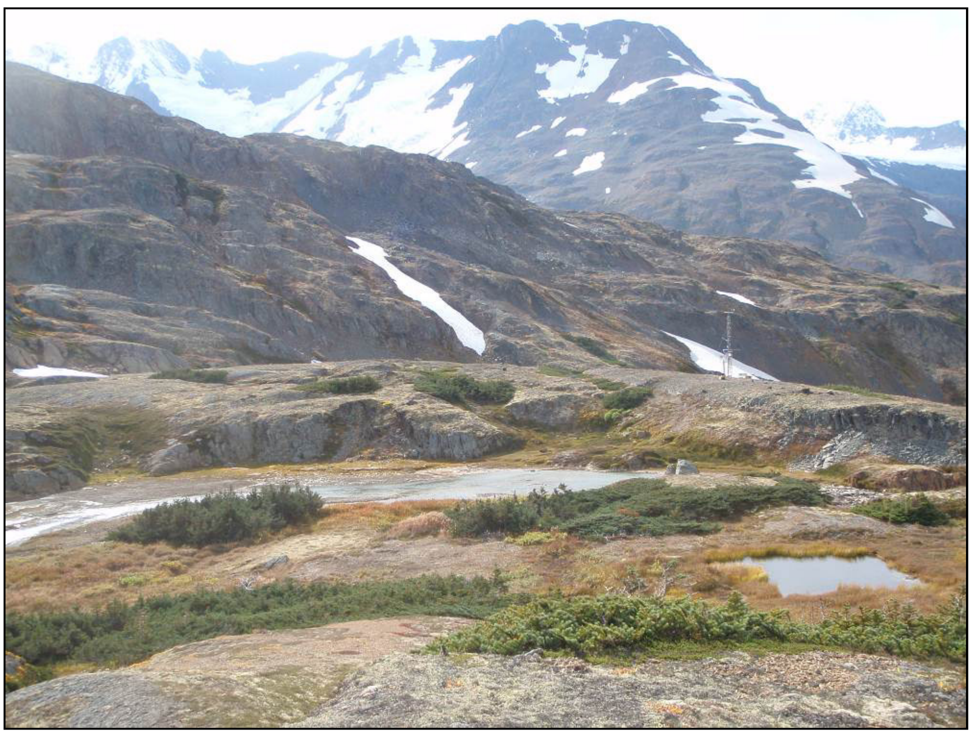

Plate 7.2-1. View of the area to the west of the Brucejack Exploration Camp showing uneven rocky terrain and sparse vegetation typical of the area.

7.3 BRUCEJACK TRANSMISSION LINE – SOUTH OPTION

The Brucejack Transmission Line – South Option route runs north from a power generating station currently under construction at the southern end of Long Lake and parallels the Granduc Road until the road ends at Tide Lake (Plate 7.3-1). The route continues north crossing the Bowser River Valley immediately west of the base of the Knipple Glacier and climbs up the mountain to the southwest of the Knipple Glacier before crossing the top of the glacier and terminating at the Brucejack Mine Site.

Plate 7.3-1. View north of the terrain along the Granduc Road. The proposed transmission line runs through the terrain to the east (right) of the road.

The terrain along the route is mountainous consisting of steep sided valley walls with small pockets of land having archaeological potential. The area also has numerous steep bedrock outcrops and loose talus slopes resulting from rockslides and slumps. Higher elevations along the edge of the Knipple Glacier and Mt. Dilworth are located within the Boreal Altai Fescue Alpine ecozone and the vegetation consists of mountain heather, patches of subalpine fir, and, at the upper edges of the zone, large areas of exposed bedrock and scree. Down slope, along the steep-sided valley walls, within the Mountain Hemlock Ecozone, the vegetation consists of hemlock and fir over blueberry with a ground cover of mountain heather and/or moss.

As the final engineering for this Project component has not been completed, the archaeological assessment fell within a 1 km buffer on each side of the proposed centreline (the LSA for this project component), with a focus on its centreline. Six slope class categories were mapped, generated from TRIM data, and reviewed for this portion of the LSA prior to and during field assessments to assist in the assessment of archaeological potential. Slope class 4 (moderately sloping, 26-50% slope) was the most common slope class, representing 32.6% of this portion of the LSA. Classes 5 and 6 (moderately steep, 50 - 70% slope, and steep, > 70% slope) represent approximately 20.7 and 13.5 % of this portion of the LSA. These three slope classes make up about 67% of the LSA along the Brucejack Transmission Line – South Option. Only 8% of this portion of the LSA is classified as level to very gentle, <5% slope

(Class 1). In general, areas with a slope of less than 25% were subject to pedestrian survey while areas with slopes greater than 25% were considered to have limited archaeological potential. Other factors were also considered in determining archaeological potential; see Section 6.2 for details.

Shovel testing was conducted at 32 locations along the Brucejack Transmission Line – South Option, with 1,059 shovel tests conducted (Plate 7.3-2). One prehistoric archaeological site (HbTm-1) was identified and a Legacy aircraft wreck site associated with a movie production (HbTm-2) was documented (see Section 7.4.2). Five historic features, likely associated with mineral exploration, were also observed (see Section 7.4.3).

Plate 7.3-2. Terrain along Brucejack Transmission Line – South Option route at shovel test location STL30.

7.4 IDENTIFIED HERTIAGE CONCERNS

There are nine archaeological sites within the RSA, including six previously recorded sites (Section 7.4.1) and three sites recorded during the archaeological assessments (Section 7.4.2). In addition, a number of historic and recent land use features were observed during the field assessment; these sites are not protected by the *HCA* but are briefly described below (Section 7.4.3).

7.4.1 Previously Recorded Archaeological Sites

As noted in Section 5.6, six archaeological sites were previously recorded with the RSA. These sites are outlined in Table 7.4-1 and are briefly described below.

7.4.1.1 HcTj-1 (Simon Gunanoot Gravesite)

Archaeological site HcTj-1, also known as the Simon Gunanoot Gravesite (see Section 5.7), is a historic burial site located on the north shore of Bowser Lake on a prominent point. The site consists of at least two burials, Simon Gunanoot and his father Johnson Nah-Gun, as well as a cabin that may predate the burials. At one time, a picket fence may have marked the burials, but by the 1980s, the fence was no longer standing and the forest had largely reclaimed the site (McLeod and McNeil 2004; Marshal, Marr, and Palmer 2008). The burials are not in proximity to any current Project components.

Table 7.4-1. Previously Recorded Archaeological Sites within the RSA

Archaeological Site	Antiquity	Site Type	General Location	Overall Site Significance Evaluation
HcTj-1	Post-contact	Human remains (grave), cabin	Bowser Lake	High
HcTo-1	Pre-contact	Prehistoric lithic scatter	Sulphurets Creek	Moderate
HdTj-1	n/a	Treaty Creek Site (Nisg̲a'a Final Agreement)	Treaty Creek	High
HdTn-1	Pre-contact	Prehistoric Lithic scatter	Mitchell Creek	Low
HdTn-2	Pre-contact	Prehistoric Lithic scatter	Mitchell Creek	Low
HdTo-7	Pre-contact	Prehistoric Lithic scatter	Sulphurets Creek	Moderate

Simon Peter Gunanoot was a business man who had a store and ranch near Hazelton. In 1906, Gunanoot was accused of murder and fled north to his families hunting territory in the Bowser Lake region. His family, along with his brother-in-laws family, evaded the law for 13 years. However, in 1919, having become something of a legend and folk hero, he turned himself in to stand trial and was acquitted of the charges. During his time on the run, he appears to have spent the majority of his time based near Bowser Lake, making trips into Hazelton and Stewart to trade for supplies (Williams 1988).

7.4.1.2 HcTo-1

Archaeological site HcTo-1 is a prehistoric (pre-contact) subsurface lithic scatter located 900 m east of the confluence of Sulphurets and Mitchell creeks. The site consists of seven utilized flakes, two retouched flakes, one notched flake, and 238 pieces of debitage. All of the artifacts recovered from the site were made of black obsidian, three of which were subject to X-Ray Fluorescence Spectrometry (XRF) analysis and were sourced to Mount Edziza (Farquharson et al. 2012). The site is interpreted as a temporary camp and/or retooling site.

7.4.1.3 HdTj-1

Archaeological site HdTj-1, also referred to as the Treaty Creek Site, is a commemorative site for a historically significant battle and subsequent peace treaty reportedly between Nisg̲a'a and the Tahltan. The site is located on the southern side of the confluence of the Bell-Irving River and Treaty Creek. The site was listed as a Provincial Heritage Site as part of the Nisg̲a'a Final Agreement (1999).

7.4.1.4 HdTn-1

Archaeological site HdTn-1 is a prehistoric (pre-contact) subsurface lithic scatter located in the subalpine on the northern side of the Mitchell Creek Valley. The site consists of 27 pieces of obsidian debitage. One piece of debitage was sent for XRF analysis and sourced to Mount Edziza (Seip et al. 2012a). The site is interpreted as a temporary camp and/or retooling site.

7.4.1.5 HdTn-2

Archaeological site HdTn-2 is a prehistoric (pre-contact) subsurface lithic scatter located in the subalpine on the northern side of the Mitchell Creek Valley. The site consists of five pieces of obsidian debitage (Seip et al. 2012a). The site is interpreted as a single use retooling site which served as a lookout over the Mitchell Creek Valley.

7.4.1.6 *HdTo-7*

Archaeological site HdTo-7 is a prehistoric (pre-contact) subsurface lithic scatter located 700 m east of the confluence of Sulphurets and Mitchell creeks. The site consists of one unifacial end-scraper, three utilized flakes, and 11 pieces of debitage. All of the artifacts recovered from the site were made of black obsidian, two of which were sent for XRF analysis and were sourced to Mount Edziza (Farquharson et al. 2012). The site is interpreted as a single use retooling site which served as a lookout over the Mitchell Creek Valley.

7.4.2 Archaeological Sites Recorded During this Study

Two prehistoric archaeological sites were recorded during the AIAs and one Legacy aircraft wreck site, associated with a movie production, was documented. These sites are described in this section along with a brief summary of site significance ratings and are summarized in Table 7.4-2 (see Section 6.4 for significance rating criteria). Details pertaining to these sites are also presented in *HCA* Heritage Inspection Permit reports for 2010-0255 and 2011-0245 (Walker and McKnight 2011, Jollymore and Walker 2013).

Table 7.4-2. Archaeological Sites Recorded During this Study within the RSA

Archaeological Site	Antiquity	Site Type	General Location	Overall Site Significance Evaluation
HbTm-1	Pre-contact	Prehistoric Lithic Scatter	Summit Lake	Low
HbTm-2	Recent Historic (Legacy Site)	Aircraft Wreckage (associated with a movie production)	Summit Lake	Low
HcTn-1	Pre-contact (Legacy Site)	Prehistoric Lithic Scatter	Brucejack Lake	Moderate

7.4.2.1 *HbTm-1*

HbTm-1 is a subsurface prehistoric lithic scatter consisting of two small andesite flakes that were recovered from a single shovel test. The site boundaries measure 10 m in diameter; it is located on a small break in slope beneath an old mining road to the east of a small creek (Plates 7.4-1 and 7.4-2). Sixty-six (66) shovels tests were conducted on the surrounding landforms with no additional prehistoric cultural materials identified. The general stratigraphy at the site consists of 0-5 cm DBS litter mat, 5-8 cm DBS moderately-compact light grey silt with some rubble (ranging between 2 and 256 cm), 8-20 cm DBS moderately-compact reddish-brown sand with some rubble, terminating at bedrock. Cultural materials were found between 5 and 8 cm DBS. Both artifacts identified in the positive shovel test were collected. The site is interpreted as a temporary camp and retooling site.

A small historic stone circle identified as a hearth feature was observed in close proximity to the site but is not related to the prehistoric site and is outside and adjacent to the site boundaires. The hearth contained a burnt sawn log, determined to be related to historic activity in the area. A collapsed historic cabin is located 100 m to the north (H-10; see Section 7.4.3).

HbTm-1 was assessed to have a low overall site significance rating. The scientific significance was considered to be low; as it is very small and contains only two non-diagnostic andesite artifacts. The ethnic significance for the site is assumed to be high for all sites as the Project area is subject to several overlapping Aboriginal territorites and no single “ethnic value” for the site is likely to be achieved. Both public and economic significance is considered to be low as the site is in a remote location, has no diagnostic artifacts, and lacks features that could be highlighted for public interpretation. Historic significance was not assessed as the site is prehistoric in origin.

Plate 7.4-1. Shovel testing at HbTm-1. View north. Hearth in foreground.

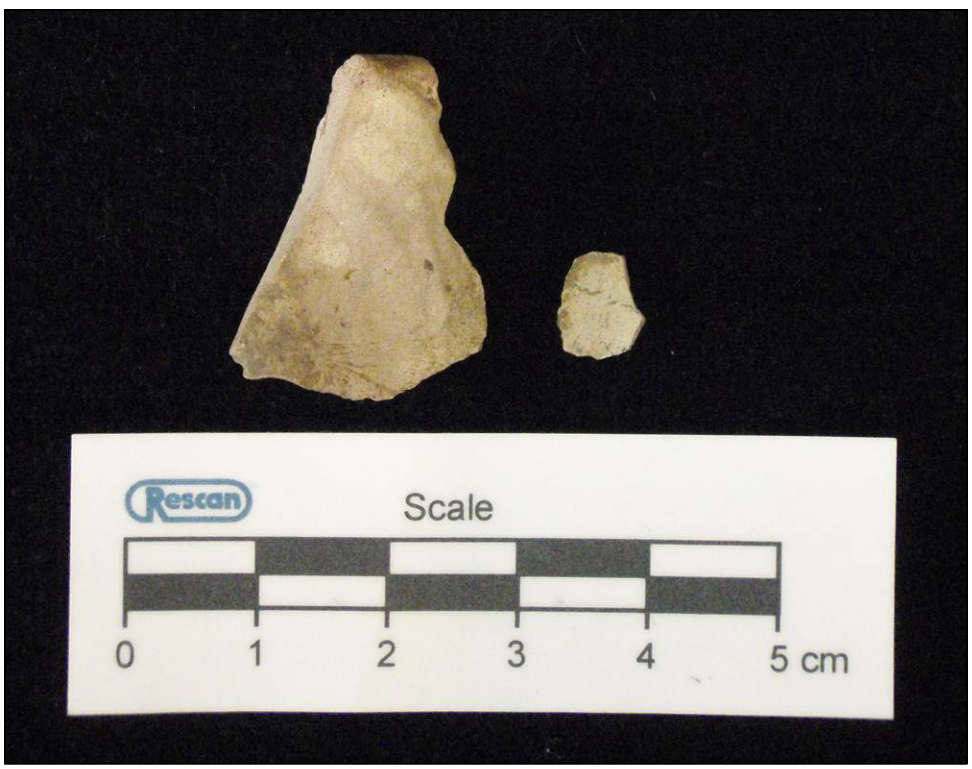

Plate 7.4-2. Andesite flakes recovered from HbTm-1.

7.4.2.2 HbTm-2

HbTm-2 is a historic aircraft wreck. A movie set and props from the filming of *The Thing* (1982) were found at this location (Outpost 31 n.d). The movie has a helicopter crash scene in it and some of the wreckage from the "crash" are still spread across the filming location. The site is situated on a man-made, levelled knoll between bedrock outcrops in the centre of a highly disturbed bench area where large amounts of fill were deposited in order to create the film set (Plate 7.4-3). The site boundaries measure 150 m in diameter taking in the disturbance area created for the film set. Parts of the helicopter wreckage, including the rotor blades, are still present at the site (Plate 7.4-4). In addition, numerous pieces of historic mineral exploration debris are spread across the large bench area (see Section 7.4.3).

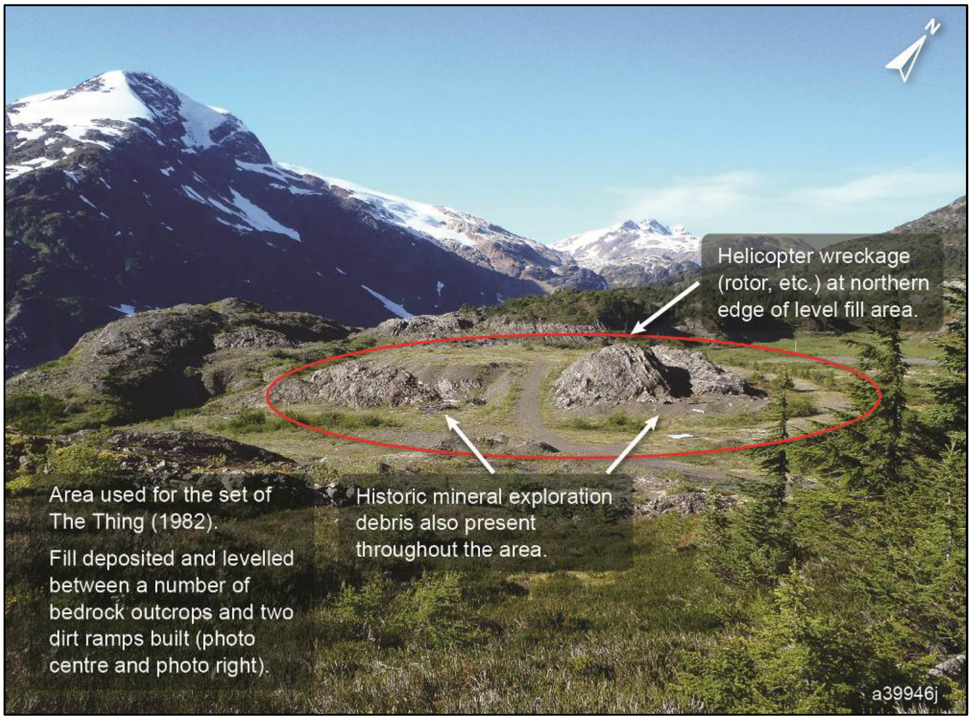

Plate 7.4-3. General layout of HbTm-2, view northwest.

The site has been assigned Legacy Status by the Archaeology Branch; the site is not protected by the *HCA* but the record will serve to document the aircraft wreckage so it is not confused at some later date as a genuine helicopter crash site.

HbTm-2 was assessed to have a low overall site significance rating. Assessments for scientific, ethnic, public and economic significance is assessed as being low as the site is related to the filming of a modern-day movie and will not contribute to our understanding of the regional prehistory, is assumed to have low ethnic value, and is in a remote location, with few "artifacts", and lacks features that could be highlighted for public interpretation. Historic significance was not assessed as the site is modern in origin.

7.4.2.3 HcTn-1

HcTn-1 is a prehistoric single artifact find located on a surface exposure of decaying bedrock on a game trail at the edge of a alpine terrace. Site boundaries measure 5 m in diameter. The site is located west of Brucejack Lake (Plates 7.4-5 and 7.4-6). Fifty-six shovels tests were conducted on the surrounding landforms and the extensive surface exposures were examined. No additional cultural materials were identified. The artifact is an obsidian utilized flake sourced to Mount Edziza Flow 3 approximately

115 km north-northwest of the site (see Appendix B). The site is interpreted as a temporary camp and/or retooling site.

Plate 7.4-4. Helicopter wreckage from the filming of The Thing *(1982) at HbTm-2.*

Plate 7.4-5. Location of artifact find on a surface exposure of decaying bedrock at HcTn-1.

Plate 7.4-6. A utilized obsidian flake recovered from HcTn-1.

The site has been assigned Legacy Status by the Archaeology Branch; the site is no long protected by the *HCA* as the site has been mitigated through surface collection. The record will serve to document site.

HcTn-1 was assessed to have a low overall site significance rating. The scientific significance was considered to be moderate; although the site is a single isolated surface find which was not diagnostic, its location in the alpine, its potential to add to the context of similar sites in the region, and its ability to trace the origin of obsidian to Flow 3 of the Mount Edziza Volcanic Complex make it moderately scientifically significant. The ethnic significance for this site is assumed to be high for all sites as the Project area is subject to several overlapping Aboriginal territorites and no single "ethnic value" for the site is likely to be achieved. Both public and economic significance is considered to be low as the site is in a remote location, has no diagnostic artifacts, and lacks features that could be highlighted for public interpretation. Historic significance was not assessed as the site is prehistoric in origin.

7.4.3 Built Heritage and Historic Features Identified

Fifteen historic features not protected under the *HCA* were documented within the RSA. These include the Catear Mine Site, a mine adit (which is once again in use for exploration purposes), two areas with recently blazed trees, two legal survey posts, and nine sites relating to historic exploration or trapping activity. The features noted in Table 7.4-3 are not exhaustive; the RSA, particularly the area south of Tide Lake inspected during the assessment of the Brucejack Transmission Line – South Option, has been subject to intensive mineral exploration since the early 1900s. The features noted in the table are included as they pre-date the current exploration activity being undertaken by Pretivm and provide context for understanding prior land use activity within the RSA. Plates 7.4-7 to 7.4-10 illustrate some of these historic features.

Table 7.4-3. Built Heritage and Historic Features

Feature #	Description	Location
H-1	Wooden stakes and flagging.	Subalpine ridge east of Todedada Creek.
H-2	Three rusty tin cans and a strip of cloth found in the littermat.	East side of Todedada Lake.
H-3	Rock pile and tin can.	East of the Sulphurets Exploration Camp.
H-4	Legal survey post, rock pile, metal debris.	South side of Brucejack Lake.
H-5	Mine adit (now in use for exploration purposes).	West of Brucejack Lake.
H-6	Recent blazed fir trees and a trail marked with flagging. Flagging leads to a nearby heli pad in a marsh.	East of Scott Creek.
H-7	Recent blazed tree with axe marks.	West side of Todedada Lake.
H-8	Abandoned Catear Resources underground mine.	Northwest of Brucejack Lake.
H-9	Legal survey post, rock pile.	West of Brucejack Lake.
H-10	Collapsed cabin and associated historic debris.	East of Summit Lake.
H-11	Two wooden tent platforms and associated historic debris.	Northwest of Premier Mine between the Salmon and Cascade rivers.
H-12	Historic debris on a machine leveled area.	Southeast of the northern end of Summit Lake.
H-13	Historic machine shed.	At top of prominent ridge above and east of Summit Lake.
H-14	Two wooden tent platforms and a small cache pit filled with old tins.	East of unnamed lake above and east of Summit Lake.
HbTm-1	Historic mineral exploration equipment and debris.	East of Summit Lake.

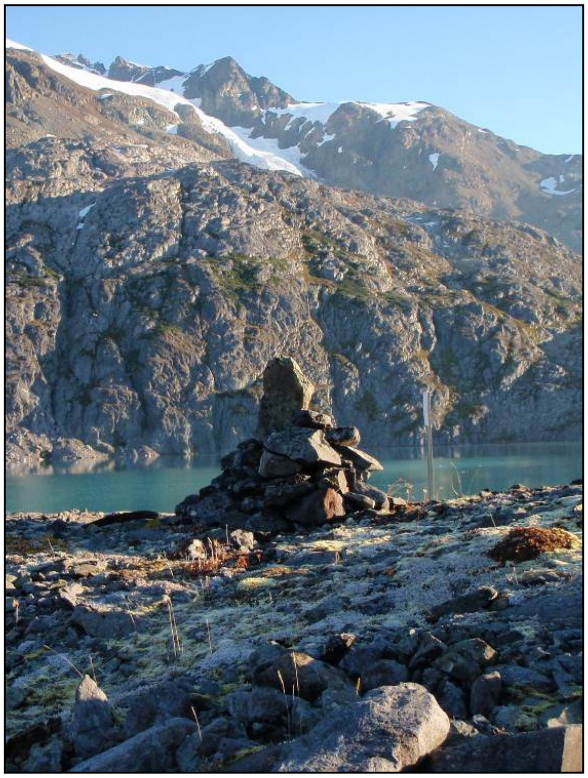

Plate 7.4-7. Survey cairn (H-4) South of Brucejack Lake.

Plate 7.4-8. Blazed fir tree (H-6) east of Scott Creek.

Plate 7.4-9. The abandoned Catear Resources Mine, northwest of Brucejack Lake (H-8).

Plate 7.4-10. Doorframe of cabin observed east of Summit Lake (H-10).

8. Conclusions

8. Conclusions

Prior to this study conducted for the Project under *HCA* Heritage Inspection Permits 2010-0255 and 2011-0245, little archaeological research had been conducted within the RSA. The recording of two new prehistoric archaeological sites and a historic site has helped to add to the body of archaeological knowledge and our understanding about the archaeological environment in the region.

During the three seasons of baseline studies conducted in 2010, 2011, and 2012 a total of nine archaeological sites were identified within the RSA, six of which were previously recorded. A total of 2,358 shovel tests were conducted in 99 locations throughout the LSA and two previously unknown prehistoric archaeological sites protected by the *HCA,* HcTn-1 and HbTm-1, were identified. HcTn-1 is located west of Brucejack Lake and HbTm-1 is located to the east of Summit Lake. HcTn-1 has been assigned Legacy Status by the Archaeology Branch as the site has been mitigated through surface collection; it is no longer protected by the *HCA*. Aircraft wreck HbTm-2, associated with a movie production, was also documented under the *HCA* and is also east of Summit Lake. This site has been assigned Legacy Status by the Archaeology Branch to document the site. Numerous historic features associated with mineral exploration and extraction within the LSA were observed; these features are not protected under the *HCA* and only some features were documented. The baseline study also included an assessment of the potential for archaeological sites on glaciers and snow patches in the RSA (Appendix A) with a field assessment conducted in the LSA. The two prehistoric sites identified during this study (HcTn-1 and HbTm-1) were both discovered on small microtopographic features, one in the alpine and the other in the subalpine. Given the rugged, mountainous, and glaciated or recently deglaciated terrain in the region, it was expected that small sites may be present in areas of higher elevation. Both sites are likely single use hunting and/or retooling sites based on their low artifact density, which speaks to the type of use the area may have had for resource procurement. No archaeological sites were identified in low laying areas, such as the confluences of streams, rivers, and/or lakes. This is not surprising given the regions glacial history in both the Salmon and the Bowser river valleys which were subject to periodic seasonal pro-glacial flooding which would have made these low laying areas less appealing for long term or reoccurring summer use. Additionally, the scouring action of these flooding events may have removed evidence of sites in these areas.

Obsidian from HcTn-1 was sourced to obsidian quarries within the Mount Edziza Volcanic Complex, approximately 115 km northwest of the site (Appendix B). This is comparable to results of XRF analysis conducted for obsidian artifacts recovered throughout the region, at such sites as HcTo-1, HdTn-1, and HdTo-7 found within the RSA (Farquharson et al. 2012, Seip et al. 2012a), as well as many other sites further north (e.g., Fladmark 1985), south (e.g., Prince 1998), and to the east (e.g., Engisch et al. 2008) which speak to the wide use of this valued resource.

Both artifacts recovered from HbTm-1 were made of a fine-grained andesite, which is likely a locally sourced material. Other sites in the region and throughout the province with assemblages that contain andesite artifacts generally have a local source. To the north of the Project, high concentrations of andesite artifacts have been documented at sites recorded near the Iskut River-More Creek confluence. Further work in this region resulted in the identification of a large andesite boulder within the site boundaries of HgTo-21 which showed evidence of heavy use as a quarry (Seip et al. 2012b). Similarly, archaeological sites with andesite artifact assemblages have been documented in the Lower Lillooet River Valley (DkRn-1), for instance, where bedrock outcrops of Cretaceous-aged formations comprised of eruptive igneous rocks such as tuff, rhyolite, and andesite are common (AMEC 2011). While a local andesite quarry was not located during the archaeological assessments, in this part of the

RSA, there are numerous bedrock outcrops which could have provided ready access to this lithic raw material which was suitable for tool production.

The Project is located in an area that has ice patches, glaciers, and recently deglaciated areas. As such, the potential for archaeological materials to occur in these areas was considered during this study. A glacial specialist reviewed the Local Study Area and Project components that are in proximity to ice patches, glaciers, and recently deglaciated areas to determine the potential for archaeological materials to be present; it was determined that the potential for sites to be present on an active glacier and ice patches is low (Appendix A). Field investigations were undertaken to confirm this assessment. No archaeological materials were found in association with ice patches, glaciers, or recently deglaciated areas.

The baseline studies undertaken for this Project were focussed on the LSA as currently proposed. Any revisions to the currently proposed Project footprint should be reviewed by a qualified professional archaeologist. Even the most thorough study may not identify all archaeological resources that may be present; an Archaeological Chance Find Procedure should be implemented prior to the commencement of ground altering activities. All Project staff should be familiarized with the procedure and the protocols for managing the known archaeological sites and any chance finds that may occur during construction.

This baseline report is intended for use by Pretium Resources Inc. This report is not an interim or final permit report. The management recommendations presented for sites within the RSA are subject to review and acceptance by the Archaeology Branch. Any use, reliance or decisions made by third parties on the basis of this report are the sole responsibility of said third parties. This study was not designed to address issues of traditional Aboriginal use and does not constitute a traditional use study. This report was written without prejudice to issues of Aboriginal rights and/or title.

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Engineers and Scientists

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

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Appendix A

Memorandum: Glaciers and Archaeology

Engineers and Scientists

MEMORANDUM	
Re:	Glaciers and Archaeology
Project:	Snowfields
Author:	Joseph M. Shea
Date:	20 December 2011
Attention:	Lisa Seip, Greg Norton

Statement of Qualifications

I am currently a post-doctoral researcher at the University of British Columbia. My research focuses on glaciers in western North America, and in particular the relation between glaciers, climate, and hydrology. I received my PhD in 2010 from the University of British Columbia, and my M.Sc. (Geography) from the University of Calgary in 2004. My undergraduate degree was completed at McMaster University (Honours B.Sc. Geography, Minor in Geology) in 2001. I have worked as a glacier consultant with Rescan Environmental Ltd. since 2008.

1 Introduction

The Snowfields study area is a heavily glaciated region that contains numerous alpine glaciers. Proposed ice roads or other glacier-based activities within the study area raise the possibility that archaeological materials may be found on or in close proximity to glaciated or recently deglaciated terrain. This memorandum examines (1) the differences between "ice patches" and "glaciers", (2) the potential for finding archaeological materials during glacier road construction, (3) an assessment of the travel risks associated with searching for archaeological remains on glaciers within the project area, and (4) the glacial history of the project area for the past 15,000 years.

2 "Ice Patch" Versus Glacier

Recent archaeological finds on and around ice patches in Tatsenshini-Alsek Park in northwest British Columbia (Beattie et al., 2000), the Mackenzie Mountains of the southern Yukon (e.g., Farnell et al., 2004; Hare et al., 2004; Dove et al., 2005) and southern Norway (Nesje et al., 2011) have demonstrated the possibility of recovering archaeological artifacts from retreating ice bodies. It is important to recognize that there are significant differences between "ice patches" and "glaciers", though both are part of the continuum of semi-permanent ice features in high alpine or high latitude environments.

2.1 Ice Patches

Ice patches are perennial snow features that persist for greater than two consecutive years, and they consist of snow and firn (multi-year snow) in their upper layers, and ice in their deeper layers. The ice layers are formed by the compaction of snow from subsequent accumulations, which generate overburden pressures. Ice patches are generally found in sheltered high-latitude or high-altitude environments where summer melt conditions are frequently insufficient for melting the previous winters snow accumulation, and they may range in length from 100 to 1,000 m, and in depth from 10 to 80 m (Meulendyk, 2010). They typically form on north or east-facing leeward slopes, or in small gullies or depressions, which receive both greater snow accumulations and lower amounts of solar radiation than the surrounding terrain. Ice patches are not sufficiently large enough (or on steep enough slopes) to generate internal flow dynamics. Ice patches are often described as glaciers in the literature, which adds some small measure of confusion to this issue.

2.2 GLACIERS

In contrast, glaciers are perennial snow and ice features that persist for greater than two years, and where mass is transferred between accumulation areas and ablation (melt) areas through sliding, ice deformation, or bed deformation. Glacier ice is formed in the same way as ice patches, and each layer of ice represents an annual layer of snow that has been compressed into ice by subsequent accumulations. Glacier velocities are typically greatest at the surface and in the interior regions of a glacier. At the base of the glacier and along the edges, frictional forces between the sliding/deforming ice mass are greater, and thus flow velocities are reduced. On larger glaciers (greater than 1 km^2), these processes are highly erosive and destructive, as evidenced by the scoured bedrock surfaces typically found in the forefield of retreating glaciers, the massive morainal deposits, and large glacial erratic boulders that can be transported significant distances from their origin by glacier ice.

2.3 ARCHAEOLOGICAL RECOVERY FROM GLACIERS AND ICE PATCHES

It is my opinion that the potential for recovering archaeological artifacts or human remains is greater for ice patches than it is for glaciers, primarily due to the lack of internal deformation or sliding on ice patches, and for the greater likelihood of human activities (e.g., hunting, travel) on or near ice patches. In the southwest Yukon, for example, ice patches are thought to provide cariboo a source of freshwater and respite from insects, indicating that they would have been good hunting grounds. Organic matter deposited on the surface of ice patches, provided it is buried rapidly and protected from the elements, can be preserved for over 8,000 years (Farnell et al., 2004).

However, it is recognized that human remains and archaeological artifacts may also be recovered from glaciers. The famous iceman “Otzi” was recovered from a glacier in the Tyrolean Alps, but preservation of the body for 5,200 years and subsequent discovery was only made possible by a remarkable series of coincidences. First, the Iceman is believed to have died on bare permafrost ground at 3,200 m, during a relatively warm period. Subsequent burial by winter snows only reached a maximum thickness of between 5 and 25 m. Due to his location on a thinly glaciated saddle, the body was protected from glacier flow by two rock ridges (Sjøvold, 1996), though the body was compressed significantly by the overburden pressure of the glacier.

Human remains (named Kwädąy Dän Ts'ìnchį, or “long ago person found”), were recovered from the edge of a small glacier in Tatshenshini-Alsek Park, in northwest British Columbia. Initial reports suggested that the individual was preserved after falling into a crevasse (Science, 1999), but it was later established that he likely died on the surface and was subsequently buried by snow and incorporated into the glacier ice (Beattie, 2000). Again, this individual was preserved primarily due to the remarkable coincidence of weather conditions at and immediately after the time of deposition, and his location near the edge of the glacier where ice flow and deformation was minimal.

3 Archaeological Potential of Project Area Glacier Roads

The Snowfields study area is heavily glacierized, with large glaciers and icefields extending from mountain top elevations to nearly 900 m above sea level (asl).

To assess the potential for finding archaeological artifacts or human remains on or near glaciers, several factors should be considered (e.g., Dixon et al., 2005):

1. The potential for human activity. Evidence of human activity, animal occurrences or trails near the proposed mine developments should indicate that the area is more likely to contain archaeological artifacts.
2. The preservation environment. The margins of glaciers will be the most likely place to find artifacts, and in particular near or above the elevation of the end-of-summer snowline. At low elevations, winter snowfalls will not be sufficient to preserve organic matter through the summer. Conversely, winter snowfall accumulations at high elevations can be greater than 6 m (Rescan, 2010) and the overburden pressure will likely destroy soft organic matter. Areas exposed to meltwater percolation or surface streams will also not be good candidates for preservation.
3. The possible travel environment. Materials deposited on the glacier surface will travel down-glacier, but as this will bring them from zones of preservation to zones of degradation. Scavengers in the environment may also remove many traces of human remains on the surface of the glacier, through stone or bone artifacts may still be preserved. Any victim falling into a crevasse on an active glacier would likely be very poorly preserved, due to the internal deformation of ice and the grinding action of the glacier over the bedrock.

It is my opinion that the probability of finding archaeological materials or human remains on the surface of the active glacier or in the immediate forefield of the glacier are very low. It is more likely that artifacts or remains might be recovered on or near stagnant ice bodies (remnant glaciers, small ice patches, or stagnant ice-cored lateral moraines) at elevations that are near or above the current end-of-summer snowline elevation.

4 Glacier Travel Risks

Glacier travel contains many risks that inexperienced or ill-prepared travellers may not be able to mitigate, and these risks vary with the season of travel, location on the glacier, and weather conditions.

Glacier travel hazards include:

- crevasses (may be visible, or hidden by snow);
- unstable snow bridges spanning crevasses;
- seracs and icefalls (falling ice blocks);
- slips and falls (and self-inflicted injuries from crampons and ice axes);
- hypothermia and frostbite (year-round);
- snow and/or ice avalanches;
- glacial moraines (steep and unstable rocky debris);

- whiteouts (navigation);
- rockfalls (from melting debris).

Travelling in glacier terrain requires a well-prepared and well-trained rope team, route-finding experience, and a thorough knowledge of crevasse rescue techniques. Rapidly changing weather conditions and frequent whiteouts or poor visibility on glaciers require that all team members be comfortable with unplanned overnight stays.

5 Regional Glacier Change History

There appears to be little direct research related to the glacial history of the project area. This section broadly describes glacier activity in western North America over the past 25,000 years, which can be grouped into four periods: the Last Glacial Maximum, the Hypsithermal, Neoglaciation, and the present. Where relevant, inferences to regional conditions have been made. A timeline summarizing the main points in this section is given in Figure 1.

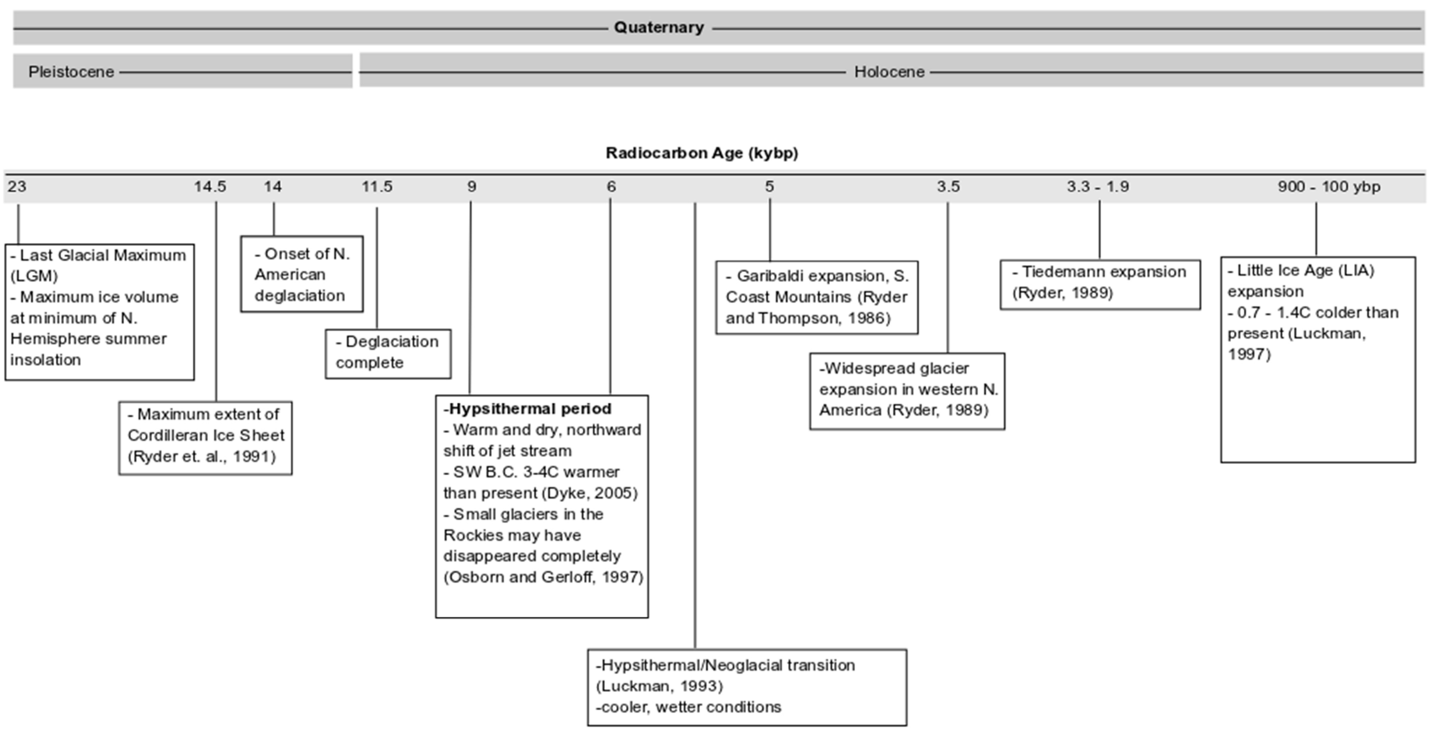

Figure 1: Summary timeline of glacial history for western Cordillera.

5.1 THE LAST GLACIAL MAXIMUM (25 KYR – 14 KYR BP)

During the Last Glacial Maximum (LGM) period, or the last great glaciation of the Pleistocene period approximately 25,000 years before present (yr BP), large ice sheets covered much of the northern Hemisphere. Growth and decay of ice sheets through the Quaternary period were driven primarily through orbital changes, which affect the amount of incoming solar radiation (insolation) received during the summer melt season. Maximum ice volumes during the LGM occurred at the trough of summer insolation in the northern hemisphere (Clark et al., 2009).

At the height of the LGM, much of Canada was covered by the Laurentide Ice Sheet, which originated in northeast Canada. The Cordilleran Ice Sheet, which coalesced from mountain glaciers in the Coast Mountains and the Rockies, covered most of British Columbia, and extended out over Vancouver Island and Haida Gwaii (Figure 1; Clague and James, 2002). Available evidence suggests that the Cordilleran Ice Sheet reached its maximum extent around 14.5 kyr BP (Ryder et al., 1991).

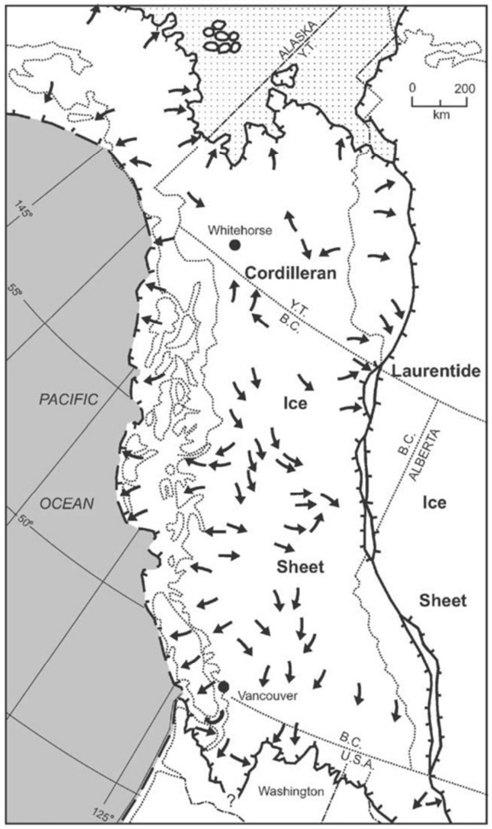

Figure 2: Maximum extent of the Cordilleran Ice Sheet during the Last Glacial Maximum, approximately 18 – 15 kyr BP (adapted from Clague and James, 2002).

5.2 DEGLACIATION (14 KYR – 10 KYR)

Cordilleran ice sheet decay began at approximately 14 kyr BP (Ryder et al., 1991), due in part to increases in summertime insolation (Clark et al., 2009). Ice sheet instabilities developed in response to increased sea levels, and marine-terminating glaciers along the west coast rapidly calved back to protected bays. By approximately 11.5 kyr BP, deglaciation was essentially complete (Ryder et al., 1991), and a rapid deglaciation is supported by observed rates of uplift in southwestern B.C. (Clague and James, 2002).

5.3 HYPSITHERMAL (9 KYR – 6 KYR)

Following the deglaciation of the Cordilleran Ice Sheet, evidence exists for active alpine glaciation and stagnant glacier tongues in in interior valleys (Clague and James, 2002). The transition to a warm and dry period known as the Hypsithermal occurred by ca. 9 kyr BP. A northward shift of the jet stream resulted in warmer temperatures across much of British

Columbia and the Yukon. Temperatures in southwestern British Columbia, for example, were approximately 3-4C warmer than present during the Hypsithermal (Dyke, 2005). Warm temperatures likely resulted in the significant retreat of alpine ice masses in northwestern British Columbia during this period, which may be relevant for archaeological studies. Small glaciers in the Canadian Rockies, for example, may have disappeared completely (Osborn and Gerloff, 1997).

5.4 NEOGLACIATION (6 KYR – 0.1 KYR BP)

The period subsequent to the Hypsithermal, known as the Neoglacial, was characterized by cooler and wetter conditions (Luckman, 1993, Mann and Hamilton, 1995) and glacier expansions throughout the western Cordillera. Several phases of glacier expansion in this period have been identified:

- the “Garibaldi” expansion occurred between 6 kyr and 5 kyr BP (Ryder and Thompson, 1986);
- the “Tiedemann” advance occurred between 3.3 and 1.9 kyr BP (Ryder and Thompson, 1986);
- the “Little Ice Age” advance, which was initiated prior to approximately 750 years BP (Jackson et al., 2008). Greatest glacier extents during the Holocene occurred during the Little Ice Age between 240 and 100 years BP;
- temperatures reconstructed from tree ring data at the Columbia Icefield suggest that average temperatures during the Little Ice Age were 0.7 – 1.4 C cooler than the 1961-1990 mean;
- at the project site, evidence for relatively recent Little Ice Age glacier extents are highly visible: polished bedrock in the glacier forefield; large, fresh lateral and terminal moraines; vegetation trimlines.

5.5 LITTLE ICE AGE – PRESENT

Since end of the Little Ice Age, rapid increases in temperature have resulted in dramatic reductions in mountain glacier volumes worldwide. The greatest changes, however, have occurred at lower elevations, with significant downwasting (lowering of the glacier surface elevation due to melt) and simultaneous glacier retreat. At long-term glacier mass balance sites, slight thickening or little to no change has been observed at the highest elevations (Dyurgerov and Meier, 2000) despite the mean temperature increases, which suggests that current glacier conditions at these elevations might not be much different from those observed during the past 1,000 years. This point may have direct relevance on the likelihood of finding archaeological materials at high elevations.

6 Summary

In heavily glaciated regions, the probability of finding human remains or archaeological materials on the surface of an actively moving alpine glacier is small. While warmer conditions and reduced glacier extents between 6,000 and 9,000 years BP may have allowed for greater human activity in the study area, subsequent glacier advancement during the late Holocene (3,000 – 100 years BP) would likely remove any traces left in the current glacier forefields. If any evidence of human activity is to be found, it is my opinion that it will most likely be located on or adjacent to small or stagnant glaciers in the study area, at an elevation that permits preservation of organic materials, and in sheltered recesses or depressions.

7 Closure

This memorandum was prepared for Rescan Environmental Ltd. The materials within this document reflect my judgement and opinion in light of information available at the time of preparation. I accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

Yours sincerely,

Joseph Shea, M.Sc., PhD

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Appendix B

X-Ray Florescence Analysis Results

X-Ray Fluorescence Analysis of Artifact Obsidian from HcTn-1, British Columbia, Canada

Craig E. Skinner and Jennifer J. Thatcher
Northwest Research Obsidian Studies Laboratory

A single obsidian artifact from HcTn-1, British Columbia, Canada, was submitted for energy dispersive X-ray fluorescence trace element provenance analysis. The sample was prepared and analyzed at the Northwest Research Obsidian Studies Laboratory under the accession number 2010-163.

Analytical Methods

X-Ray Fluorescence Analysis. Nondestructive trace element analysis of the sample was completed using a Spectrace 5000 energy dispersive X-ray fluorescence spectrometer. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area 30 mm^2. Signals from the spectrometer are amplified and filtered by a time variant pulse processor and sent to a 100 MHZ Wilkinson type analog-to-digital converter. The X-ray tube employed is a Bremsstrahlung type, with a rhodium target, and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 4 to 50 kV. For the elements Zn, Rb, Sr, Y, Zr, Nb, and Pb that are reported in Table A-1, we analyzed the collection with a collimator installed and used a 45 kV tube voltage setting and 0.60 mA tube current setting.

The diagnostic trace element values used to characterize the sample are compared directly to those for known obsidian sources reported in the literature and with unpublished trace element data collected through analysis of geologic source samples (Northwest Research 2010a). Artifacts are correlated to a parent obsidian source (or geochemical source group) if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Occasionally, visual attributes are used to corroborate the source assignments although sources are never assigned solely on the basis of megascopic characteristics.

Additional details about specific analytical methods and procedures used for the analysis of the elements reported in Table A-1 are available at the Northwest Research Obsidian Studies Laboratory World Wide Web site at *www.obsidianlab.com.*

Results of Analysis

X-Ray Fluorescence Analysis. The trace element profile of the geochemically characterized artifact from HcTn-1 indicates that it originated from the Mt. Edziza Volcanic Field located in northwestern British Columbia. Analytical results are presented in Table A-1 in the Appendix and are summarized in Table 1.

Figure 1. Locations of the project site and the source of the analyzed artifact.

At least 10
different geochemical sources of obsidian from the Mt. Edziza Volcanic Field have been identified by Godfrey-Smith (1985) and our modest collection of analyzed comparative samples from this area includes only a subset of these. However, the trace element composition of the artifact analyzed in the current investigation failed to unambiguously match any of those reference specimens. We instead used an alternative approach with which to assign the artifact to a specific Mt. Edziza flow. Three artifacts that had been previously analyzed by the Simon Fraser University (SFU) XRF Laboratory and assigned to the Mt. Edziza 2 and Mt. Edziza 3 flows were reanalyzed by our laboratory. Although extensive trace element obsidian source data are available from the SFU XRF Laboratory (see D'auria et al. 1992), the results are semi-quantitative and are not directly comparable to the quantitative (parts per million) analytical results produced by Northwest Research. The trace element profiles resulting from the analysis of the three previously characterized artifacts were then compared to that of the artifact from HcTn-1. The composition of the Mt. Edziza Flow 3 source identified by the SFU XRF Laboratory clearly matched that of the artifact from the current investigation

Further studies about the geologic setting and prehistoric use of the Mt. Edziza sources may be found in Aumento and Souther (1973), Carlson (1994), D'Auria et al. (1992), Fladmark (1984, 1985), Godfrey-Smith (1985), Nelson et al. (1975), Souther (1992), and Souther et al. (1984).

Additional information about the sources may also be found at *www.sourcecatalog.com* (Northwest Research 2010b).

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Northwest Research Obsidian Studies Laboratory
2010a Northwest Research Obsidian Studies Laboratory World Wide Web Site (www.obsidianlab.com).

2010b Northwest Research United States and Canada Obsidian Source Catalog (www.sourcecatalog.com).

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Appendix

Results of X-Ray Fluorescence Analysis

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: HcTn-1, British Columbia, Canada

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe_2O_3^T$	Fe:Mn	Fe:Ti	
HcTn-1	1	HcTn-1:1	239	28	207	10	111	1007	132	1191	336	0	2.09	50.2	55.9	Mt. Edziza Flow 3
			± 17	6	5	9	4	8	2	99	32	23	0.14			
NA	RGM-1	RGM-1	32	25	153	99	28	218	9	1542	294	696	1.67	46.3	35.2	RGM-1 Reference Standard
			± 17	5	4	9	4	7	2	101	32	25	0.14			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured; * = Small sample; FGV = Fine-grained volcanic specimen.